Loup River Hydroelectric Project
FERC Project No. 1256

Final License Application
Volume 3 of 5
Final Study Report

Loup Power District
Hydro Project

April 13, 2012

Serving You Electrically
LOUP POWER DISTRICT

Loup Power District
Hydro Project

Loup River Hydroelectric Project
FERC Project No. 1256

Final License Application
Volume 3 – Final Study Report

April 13, 2012

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LIST OF APPENDICES

INTRODUCTION

Loup River Public Power District (Loup Power District or the District) has prepared this Final Study Report for filing with the Federal Energy Regulatory Commission (FERC) as part of relicensing the Loup River Hydroelectric Project (FERC Project No. 1256). This Final Study Report is a compilation of the study reports filed by the District throughout the relicensing process. This Final Study Report is being filed electronically with FERC and appropriate agencies and stakeholders as Volume 3 of the District's Final License Application. In addition, agencies and stakeholders known to have an interest in the proceeding have been notified via email of the availability of the Final Study Report on the District's relicensing website:

http://www.loup.com/relicense

A. PROJECT BACKGROUND

The Loup River Hydroelectric Project (Project) is located in Nance and Platte counties, Nebraska, where water is diverted from the Loup River and routed through the 35-mile-long Loup Power Canal, which empties into the Platte River near Columbus. The Project includes various hydraulic structures, two powerhouses, and two regulating reservoirs, as shown in Figure 1. The current license for the Project expires on April 15, 2014. Therefore, the District is seeking a new license to continue to operate the Project.

B. STATUS OF STUDIES

All studies conducted for the relicensing proceeding are complete and are included as appendices in this Final Study Report. In addition, a summary of each study report is included in the sections that follow this introduction. Each study is listed below along with details of the original submittal; this information is summarized in Table 1:

- Study 1.0, Sedimentation – The sedimentation study is complete. The results of this study were presented in the Initial Study Report (ISR) and Second ISR, and those reports were combined in the Updated Study Report (USR). In addition, study modifications identified by FERC were included in the USR. A summary of the goals and objectives, study area, methods, and results is provided in Section 1. The final Sedimentation Study Report is included as Appendix A.
- Study 2.0, Hydrocycling – The hydrocycling study is complete. The results of this study were presented in the Second ISR, and study modifications identified by FERC were included in the USR. A summary of the goals and objectives, study area, methods, and results is provided in Section 2. The final Hydrocycling Study Report is included as Appendix B.

R-4-W
R-3-W
R-2-W
R-1-W
R-1-E
R-2-E
T-18-N
T-17-N
T-16-N
Looking Glass Creek
Dry Cherry Creek Siphon
Monroe Powerhouse
Shell Creek
Lost Creek Ditch
Lower Power Canal
Lake Babcock
Lake North
Intake Canal
Dry Cherry Creek
Upper Power Canal
Beaver Creek
916 Siphon
Oconee Siphon
Sawtooth Weir
Columbus Powerhouse
Monroe
Railroad Siphon
Looking Glass Creek Siphon
Beaver Creek Siphon
Genoa
Loup River
Columbus
Tailrace Canal
Lost Creek Siphon
Settling Basin
Lost Creek
Skimming Weir
Platte County
Platte River
Outlet Weir
Nance County
Merrick County
Polk County
Butler County
Diversion Weir
Project Location
Nance & Platte Counties, Nebraska
2 1 0 2
Miles
Aerial Imagery: 2010 National Agricultural Inventory Project, Nance and Platte Counties Mosaic.
Coporate Limits: 2010 Census Tiger Files
Waterway: 2011 National Hydrography Dataset (NHD)
Stream Areas/Lakes: 2000 Tiger Line Files, Platte and Nance Counties.

Legend
- Loup Power Canal
- Waterway
- Corporate Limits
- Township/Range
- County Line

Loup Power District Hydro Project

Project Location

Loup River Hydroelectric Project
FERC Project No. 1256
Final Study Report

DATE
April 2012

FIGURE
1

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- Study 3.0, Water Temperature in the Platte River – The water temperature in the Platte River study was determined unnecessary for relicensing purposes in FERC's Study Plan Determination. The rationale is provided in Section 3.
- Study 4.0, Water Temperature in the Project Bypass Reach – The study of water temperature in the Project bypass reach is complete. The completed study report was provided in the District's February 11, 2011, Second ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan. A summary of the goals and objectives, study area, methods, and results is provided in Section 4. The final Water Temperature in the Project Bypass Reach Study Report is included as Appendix C.
- Study 5.0, Flow Depletion and Flow Diversion – The flow depletion and flow diversion study is complete. The completed study report was provided in the District's February 11, 2011, Second ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan. A summary of the goals and objectives, study area, methods, and results is provided in Section 5. The final Flow Depletion and Flow Diversion Study Report is included as Appendix D.
- Study 6.0, Fish Sampling – The fish sampling study was determined unnecessary for relicensing purposes in FERC's Study Plan Determination. The rationale is provided in Section 6.
- Study 7.0, Fish Passage – The fish passage study is complete. The completed study report was provided in the District's August 26, 2010, ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan. A summary of the goals and objectives, study area, methods, and results is provided in Section 7. The final Fish Passage Study Report is included as Appendix E.
- Study 8.0, Recreation Use – The recreation use study is complete. In accordance with FERC's August 26, 2009, Study Plan Determination, interim results of the telephone survey were provided in the District's August 26, 2010, ISR filing, and an Interim General Recreation Use report was filed on September 15, 2010. The Interim General Recreation Use report was wholly incorporated into the General Recreation Use report and is not provided herein. The completed recreation use study report, including a creel survey report, was provided in the District's February 11, 2011, Second ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan.
  A summary of the goals and objectives, study area, methods, and results is provided in Section 8. The final Recreation Use Study Report is included

as Appendix F. The District's Recreation Management Plan is included in Volume 2, Exhibit E, of the District's Final License Application.

- Study 9.0, Creel Survey – The creel survey was combined with Study 8.0, Recreation Use (see above), consistent with the RSP, agency input, and FERC's Study Plan Determination. The rationale is provided in Section 9.
- Study 10.0, Land Use Inventory – The land use inventory is complete. The completed study report was provided in the District's August 26, 2010, ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan. A summary of the goals and objectives, study area, methods, and results is provided in Section 10. The final Land Use Inventory Study Report is included as Appendix G.
- Study 11.0, Section 106 Compliance – All components of the Section 106 compliance study are complete, with the exception of a Programmatic Agreement. The Nebraska State Historic Preservation Office (Nebraska SHPO) has reviewed and concurred with the findings of the following: Phase IA Archaeological Overview, Phase I/II Archaeological Inventory and Evaluation, Historic Building Inventory and Evaluation, and Phase I/II Archaeological Inventory and Evaluation Addendum. Additionally, Native American tribes have been afforded an opportunity to review the Phase IA Archaeological Inventory and the Phase I/II Archaeological Inventory and Evaluation and have provided no comments to date. The reports were filed with FERC as follows:
    - Phase IA Archaeological Overview – Filed with FERC as Privileged information on December 4, 2009.
    - Phase I/II Archaeological Inventory and Evaluation – Filed with FERC as Privileged information on September 24, 2010.
    - Historic Building Inventory and Evaluation – Filed with FERC on September 24, 2010.
    - Phase I/II Archaeological Inventory and Evaluation Addendum – Filed with FERC as Privileged information on February 14, 2011.

  In addition, the Ethnographic Documentation is complete and was included in the District's August 26, 2011, USR filing.

  Finally, the District has prepared its Historic Properties Management Plan (HPMP) and provided it to Nebraska SHPO and Native American tribes for review. Nebraska SHPO concurred with the HPMP on March 12, 2012. To date, no comments have been received from Native American tribes. The District's HPMP is included in the Final License Application, Volume 4, Privileged. Following FERC approval of the HPMP, a

Programmatic Agreement will be developed in consultation with FERC and Nebraska SHPO.

An overall summary of the goals and objectives, study area, methods, and results is provided in Section 11. The portions of the final Section 106 Compliance Study Report that are not privileged are included as Appendix H. The portions that are privileged are provided in the Final License Application, Volume 4, Privileged.

- Study 12.0, Ice Jam Flooding on the Loup River – The study of ice jam flooding on the Loup River is complete. The completed study report was provided in the District's February 11, 2011, Second ISR filing. No modifications were required in FERC's Determination on Requests for Modifications to the study plan. A summary of the goals and objectives, study area, methods, and results is provided in Section 12. The final Ice Jam Flooding on the Loup River Study Report is included as Appendix I.
- Study 13.0, PCB Fish Tissue Sampling – Although polychlorinated biphenyl (PCB) fish tissue sampling was not a formal study, it is referred to as Study 13.0 in the District's Final License Application. The Nebraska Department of Environmental Quality (NDEQ) completed fish tissue sampling in 2009, and the U.S. Environmental Protection Agency, Region 7 completed analysis of those samples in 2010, as required by FERC's Study Plan Determination. A summary of the goals and objectives, study area, methods, and results of the performed analysis was provided in the District's August 26, 2010, ISR filing as well as in the Second ISR and USR. This summary has not been modified and is included in Section 13.
- Study 14.0, Alternative Project Operations and Sediment Management – A study of alternative Project operations and sediment management was required by FERC in its December 21, 2011, Determination on Requests for Modifications to the Loup River Hydroelectric Project Study Plan following comments on the District's USR. A summary of the alternatives, study area, methods, and results is provided in Section 14. The Alternative Project Operations and Sediment Management Study Report is included as Appendix J.
- Summary of Study Results Related to the Interior Least Tern and Piping Plover – FERC requested, in its April 8, 2011, comments on the Second ISR, "a summary that synthesizes the results of the [sedimentation, hydrocycling, and flow depletion and flow diversion] studies to discuss how the results obtained from each study [have] the potential to collectively impact the presence, absence, and/or nesting success of piping plovers and interior least terns." A Summary of Study Results Related to the Interior Least Tern and Piping Plover was provided in the District's August 26, 2011, USR filing and is included in this Final Study Report as Appendix K.

Table 1. Final Study Reports

Appendix	Title	Publication	Date
A	Sedimentation Study Report	USR	August 26, 2011
B	Hydrocycling Study Report	USR	August 26, 2011
C	Water Temperature in the Project Bypass Reach Study Report	Second ISR	February 11, 2011
D	Flow Depletion and Flow Diversion Study Report	Second ISR	February 11, 2011
E	Fish Passage Study Report	ISR	August 26, 2010
F	Recreation Use Study Report	ISR Second ISR	August 26, 2010 February 11, 2011
G	Land Use Inventory Study Report	ISR	August 26, 2010
H	Section 106 Compliance Study Report	USR	August 26, 2011
I	Ice Jam Flooding on the Loup River Study Report	Second ISR	February 11, 2011
J	PCB Fish Tissue Sampling	ISR	August 26, 2010
K	Alternative Project Operations and Sediment Management Study Report	Final Study Report	April 13, 2012
L	Summary of Study Results Related to the Interior Least Tern and Piping Plover	USR	August 26, 2011

SECTION 1 STUDY 1.0, SEDIMENTATION

1.1 GOALS AND OBJECTIVES OF STUDY

The goal of the sedimentation study is to determine the effect, if any, that Project operations have on stream morphology and sediment transport in the Loup River bypass reach and in the lower Platte River[1] because stream morphology relates directly to habitat, and habitat may determine species abundance and success. In addition, the study will compare the availability of sandbar nesting habitat for interior least terns and piping plovers to their respective populations and will compare the general habitat characteristics of the pallid sturgeon in multiple locations.

The objectives of the sedimentation study are as follows:

1. To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.
2. To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.
3. To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by the Nebraska Game and Parks Commission [NGPC]) and productivity measures.[2]
4. To determine if sediment transport is a limiting factor for pallid sturgeon habitat in the lower Platte River below the Elkhorn River.

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[1] The lower Platte River is defined as the reach between the confluence of the Loup and Platte rivers and the confluence of the Platte and Missouri rivers.

[2] It was determined at the May 27-28, 2009, Study Plan Meeting that productivity measures (fledge ratios) are also an important indicator of the reproductive success of interior least terns and piping plovers. These data were provided to the District by NGPC for use in this study; however, limited data exist for interior least terns and piping plovers on the Loup and lower Platte rivers. Fledge ratios only exist for a few select sandpit sites adjacent to the Loup and Platte rivers between 2000 and 2008. 2005 is the only year of productivity data provided for sandbars in the Loup River. 2008 is the only year of productivity data provided for sandbars in the lower Platte River.

1.2 STUDY AREA

The study area includes the Loup River from approximately 5 miles upstream of the Diversion Weir, the Loup River bypass reach, and the lower Platte River. Specific study sites were selected based on the availability of gaged flow data from the U.S. Geological Survey (USGS) and Nebraska Department of Natural Resources (NDNR). The following gage stations were used as study sites:

- USGS Gage 06793000, Loup River near Genoa, NE
- USGS Gage 06794500, Loup River at Columbus, NE
- USGS Gage 06774000, Platte River near Duncan, NE
- USGS Gage 06796000, Platte River at North Bend, NE
- USGS Gage 06796500, Platte River at Leshara, NE
- USGS Gage 06801000, Platte River near Ashland, NE
- USGS Gage 06805500, Platte River at Louisville, NE

In addition to these gaged sites, three "ungaged" sites were to be evaluated. However, because data from two additional ungaged sites were required for other studies (that is, the hydrocycling and the flow depletion and flow diversion studies), the following five ungaged sites were evaluated in the sedimentation study:

- Loup River upstream of the Diversion Weir (Site 1)
- Loup River immediately downstream of the Diversion Weir (Site 2)
- Lower Platte River downstream of the Loup River confluence and upstream of the Tailrace Return confluence (Site 3)
- Lower Platte River within 5 miles downstream of the Tailrace Return confluence (Site 4)
- Lower Platte River near the USGS North Bend gage (Site 5)

Sites 1, 3, and 4 are those required for the sedimentation study. Site 1, on the Loup River, was identified in the Revised Study Plan, and Sites 3 and 4, on the lower Platte River, were added by FERC in its Study Plan Determination dated August 26, 2009.

1.3 METHODOLOGY

The methodology for the sedimentation study includes six tasks designed to meet the four objectives presented in Section 1.1, Goals and Objectives of Study. The objectives are repeated below, followed by the tasks that were conducted to meet each objective. Task 1, Literature Review and Data Collection, however, is required prior to initiation of the other tasks and is not associated with one specific objective.

Task 1 Literature Review and Data Collection

Numerous reports and data sets regarding the Loup and Platte rivers and regarding threatened or endangered species near the Project were available from USGS and others. All relevant reports and existing data were obtained and reviewed. In addition, cross-section surveys were conducted at the ungaged sites listed in Section 1.2, Study Area, on two occasions: May to July 2010 and September to October 2010.

Objective 1: To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.

Task 2 Sediment Budget

The first task in characterizing sediment transport was to develop an updated sediment budget. The updated sediment budget, including sediment yield estimates, was developed based on the sediment budget and sediment yield analysis completed by the Missouri River Basin Commission (MRBC) in September 1975. The MRBC yields were adjusted based on the District's dredging records since Project inception.

Task 3 Effective Discharge and Other Sediment Transport Calculations

The second task in characterizing sediment transport was to determine the sediment transport capacity at the gaged and ungaged sites. The methodology used is based on calculating daily values of the capacity of flows to transport bed material sediments in shaping the river. First, a relationship was calculated between flow and sediment transport, resulting in sediment discharge rating curves. Second, from this relationship, several sediment transport indicators were calculated: total sediment transport capacity, effective discharge, and dominant discharge.

In addition, a spatial analysis was conducted to assess whether the sediment transport indicators and the regime analysis suggest that the morphological indicators from upstream to downstream at the gaged and ungaged sites are consistent with natural river processes.

Objective 2: To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.

Task 4 Stream Channel Morphology

The methodology for evaluating the current stream channel morphology included the following:

- Conducting a specific gage analysis and associated Kendall tau analysis
- Determining sediment transport parameters, including daily calculations of the capacity of discharges to transport bed material sediment

- Grouping daily transport values to determine which discharges are "effective" or "dominant" in shaping the morphologies (and habitat) of the Loup River bypass reach and the lower Platte River by transporting the greatest amount of sediment
- Assessing short- and long-term values of cumulative bed material transport
- Comparing cumulative sediment transport capacities with adjusted MRBC annual sediment yield estimates
- Applying regime theory to the effective discharges to assess whether the morphologies of the Loup River bypass reach and the lower Platte River are in dynamic equilibrium

Objective 3: To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by NGPC) and productivity measures.

Task 5 Interior Least Tern and Piping Plover Nesting and Sediment Transport Parameters

The District's Revised Study Plan included conducting a statistical analysis to test for a relationship between sediment transport parameters and interior least tern and piping plover nest counts. An initial statistical analysis was conducted at a course spatial scale based on river segments associated with sediment transport and other hydrologic parameters. The analysis included comparing nest counts to the following sediment transport and hydrologic parameters to determine if a relationship could be detected between the parameter and the nest counts:

- Annual effective discharge
- Annual dominant discharge
- Seasonal dominant discharge
- Annual cumulative sediment discharge
- Seasonal cumulative sediment discharge
- Annual cumulative flow
- Seasonal cumulative flow
- Annual peak mean daily flow
- Seasonal peak mean daily flow
- Annual flow width from effective discharge
- Annual flow width from dominant discharge

- Seasonal flow width from dominant discharge
- Annual percent diverted flow
- Seasonal percent diverted flow

Additionally, a linear regression analysis was performed, a graph was developed, and a coefficient of determination (R^2) was generated for each analysis.

In response to comments received on the ISR, the District conducted a supplemental statistical analysis at a finer spatial scale (by river mile), reduced the number of hydrologic variables for analysis, and used additional statistical methods.

Objective 4: To determine if sediment transport is a limiting factor for pallid sturgeon habitat in the lower Platte River below the Elkhorn River.

Task 6 Pallid Sturgeon Habitat

The sediment transport data were reviewed to determine if the Project is affecting morphology in the lower Platte River. In accordance with the RSP and Study Plan Determination, if it is determined that the Project does not affect morphology in this reach, or that the system is in dynamic equilibrium, it will be inferred that the Project does not affect pallid sturgeon habitat parameters related to sediment transport and that no further analysis is warranted.

If the analysis shows that the Project is affecting morphology, the magnitude of Project effects will be determined using effective discharge calculations and aggradation/degradation and other morphologic change analysis, as detailed in Task 4, Stream Channel Morphology. Additionally, the existing condition, with regard to sediment transport and braided river morphology in the lower Platte River, would be compared to habitat characteristics of other rivers used by the pallid sturgeon to determine if changes in Project operations relative to sediment transport could affect pallid sturgeon use of the lower Platte River.

1.4 RESULTS AND DISCUSSION

The body of literature cited and the supplemental analyses at the gaged and ungaged sites demonstrate that the Loup River bypass reach and the lower Platte River are in regime and are seated well within regime zones considered as braided streams. Further, the analyses and other supporting literature cited clearly indicate that both the Loup River bypass reach and the lower Platte River at all locations studied are clearly in regime, not supply limited, and not aggrading or degrading, with no indications of channel geometry characteristic (width and depth) changes over time.

Objective 1: To characterize sediment transport in the Loup River bypass reach and in the lower Platte River through effective discharge and other sediment transport calculations.

The sedimentation study, including the collection and analysis of data at both gaged and ungaged sites, supports the conclusion that the sediment availability and yield throughout the study area by far exceed the capacity of the flow to transport sediment as well as greatly exceed the actual measured amounts of suspended sediment being transported.

The U.S. Army Corps of Engineers (USACE) came to the same conclusion. The supply of sediment throughout the Platte River Basin, including the Loup River Basin, is "virtually unlimited" (USACE, July 1990) and is significantly greater than both the Loup and Platte rivers' capacities to move the sediment. This means that the Loup River bypass reach and the lower Platte River can be considered to be in an equilibrium condition, with supplies in excess of transport capacity with no evidence of degradation in the channel. USACE noted that an excess of supply over transport capacity exists, as manifested by sand and gravel deposits along banks and in the stream as sand bars (USACE, July 1990).

As noted in the methodology described in Section 1.3, if the capacity for total bed material sediment transport for a given time period were equal to or less than the sediment yield, it would be concluded that the braided river is not supply limited and is currently in dynamic equilibrium. The results of the collection and analysis of data at both gaged and ungaged sites show that both the Loup River bypass reach and the lower Platte River at all locations studied are clearly not supply limited.

Effective discharge and other sediment transport and hydraulic geometry calculations, combined with river regime theory, show that the channel geometries are "in regime" with the long-term flows shaping them. The current channel hydraulic geometries match the width, depth, and velocity calculations for flow rates matching the effective and dominant discharge rates. Nothing appears to be constraining either the Loup or the Platte River from maintaining the braided river hydraulic geometry associated with the effective discharges.

The cross-section data at the ungaged sites reveal that the braided channel geometry of both rivers is not only widely diverse over a few hundred feet of length, but highly subject to dramatic changes over a few months' time. The cross sections both upstream and downstream of the Tailrace Return exhibited similar cross-section changes. Any measured or calculated adjustment in geometry cannot be readily attributed to any other cause than the natural dynamics of a braided river.

The spatial analysis shows that the morphologies and subsequent habitat, as measured by comparing the channel geomorphologic characteristics with effective and dominant discharge, is consistent with natural river processes. No identifiable Project impacts on the morphology occur at any individual study sites or between any sets of two or more adjacent sites.

The methodology established that if the literature review, sediment transport calculations, specific gage analysis, and regime analysis indicate that short-term fluctuations in the morphology of the Loup River bypass reach and lower Platte River are not transitioning to another form, it would be further affirmed that the rivers are currently in dynamic equilibrium. The combinations of slopes, sediment sizes, and effective discharges at all of the gaged and ungaged sites result in all locations being well within braided river morphologies, with none being near any thresholds of transitioning to another morphology.

Finally, the methodology established that if the analysis of the current condition morphology indicates that the Loup River bypass reach and lower Platte River are in dynamic equilibrium or are not supply limited based on the adjusted yields and sediment transport capacity calculations, then no alternatives relative to sediment augmentation would be evaluated.

Objective 2: To characterize stream morphology in the Loup River bypass reach and in the lower Platte River by reviewing existing data and literature on channel aggradation/degradation and cross sectional changes over time.

Existing literature, including Platte River studies by USACE, U.S. Department of the Interior Bureau of Reclamation (USBR), and USGS; calculations of effective discharges; regime analyses; literature on the channels' profiles; and physical observations indicate that the Loup River bypass reach and the lower Platte River are not experiencing aggradation or degradation. Instead, these analyses, particularly the bed gradation studies by others and the effective discharge and regime analysis, clearly indicate that both the Loup and lower Platte rivers are well within parameters establishing them as dynamically stable, non-aggrading and non-degrading, braided rivers.

Objective 3: To determine if a relationship can be detected between sediment transport parameters and interior least tern and piping plover nest counts (as provided by NGPC) and productivity measures.

The initial statistical analysis yielded results of no significant relationship between interior least tern and piping plover nest counts and sediment transport indicators. No evidence from this analysis was discovered that would suggest that a relationship exists between nest counts and sediment transport indicators or hydrologic parameters.

The results of the supplemental statistical analysis will be provided in an addendum prior to the Updated Study Results Meeting.

Objective 4: To determine if sediment transport is a limiting factor for pallid sturgeon habitat in the lower Platte River below the Elkhorn River.

The findings of this sedimentation study determined that the lower Platte River geomorphology and corresponding riverine habitat are in dynamic equilibrium. When these findings are compared to the numbers of shovelnose and pallid sturgeon collected during ongoing capture efforts, it can be inferred that current Project operations relative to sediment removal from Loup River inflows at the Headworks are not acting to limit sturgeon habitat or the success of these species in the lower Platte River.

SECTION 2 STUDY 2.0, HYDROCYCLING

2.1 GOALS AND OBJECTIVES OF STUDY

The goal of the hydrocycling study is to determine if Project hydrocycling operations benefit or adversely affect the habitat used by interior least terns, piping plovers, and pallid sturgeon in the lower Platte River. The physical effects of hydrocycling (current operations) were quantified and compared to an alternative condition (run-of-river operations). Run-of-river operations are defined as simulated conditions that would exist without regulation for hydrocycling.

The objectives of the hydrocycling study are as follows:

1. To compare the sub-daily Project hydrocycling operation values (maximum and minimum flow and stage) to daily values (mean flow and stage). In addition to same-day comparisons, periods of weeks, months, and specific seasons of interest to protected species will be evaluated to characterize the relative degrees of variance between hydrocycling (current operations) and run-of-river operations in the study area.
2. To determine the potential for nest inundation due to both hydrocycling (current operations) and run-of-river operations.
3. To assess effects, if any, of hydrocycling (current operations) and run-of-river operations on sediment transport parameters and channel morphology (see Study 1.0, Sedimentation).
4. To identify material differences between hydrocycling (current operations) and run-of-river operations in potential effects on habitat of the interior least tern, piping plover, and pallid sturgeon.

2.2 STUDY AREA

The study area includes the Tailrace Canal and the lower Platte River from the Project Outlet Weir to the USGS gage at Louisville. Stream gage information from upstream locations on both the Loup River and central Platte River were used in development of flow information at the Outlet Weir location. The following existing stream gage locations on the lower Platte River served as study sites for analyses:

- USGS Gage 06796000, Platte River at North Bend, NE
- USGS Gage 06796500, Platte River at Leshara, NE
- USGS Gage 06801000, Platte River near Ashland, NE
- USGS Gage 06805500, Platte River at Louisville, NE

In addition to these study sites, FERC, in its Study Plan Determination dated August 26, 2009, required that "ungaged" sites also be evaluated. The approved methodology for the hydrocycling study included a provision that cross-section surveys and calculations of sediment transport indicators, regime analysis, and spatial analysis be conducted at three ungaged sites. In addition, the approved methodology for the sedimentation and the flow depletion and flow diversion studies included a provision that cross-section surveys and calculations of sediment transport indicators be conducted at two additional ungaged sites.

The ungaged sites were chosen in consultation with the U.S. Fish and Wildlife Service (USFWS) and NGPC through the use of aerial photographs. The five ungaged sites and the studies with which they are associated are listed below; the three ungaged sites relevant to this hydrocycling study are Sites 3, 4, and 5:

1. Loup River upstream of the Diversion Weir (Site 1) – Sedimentation and flow depletion and flow diversion
2. Loup River immediately downstream of the Diversion Weir (Site 2) – Flow depletion and flow diversion
3. Lower Platte River downstream of the Loup River confluence and upstream of the Tailrace Return confluence (Site 3) – Sedimentation, hydrocycling, and flow depletion and flow diversion
4. Lower Platte River within 5 miles downstream of the Tailrace Return confluence (Site 4) – Sedimentation and hydrocycling
5. Lower Platte River near the USGS North Bend gage (Site 5) – Hydrocycling

2.3 METHODOLOGY

The methodology for the hydrocycling study includes six tasks designed to meet the four objectives presented in Section 2.1, Goals and Objectives of Study. The objectives are repeated below, followed by the tasks conducted to meet each objective. Task 1, Data Collection, however, is required prior to initiation of the other tasks and is not associated with one specific objective.

Task 1 Data Collection

Daily and sub-daily discharge data, streamflow measurements, and current and historical rating curve data were collected at the study sites as well as at additional USGS and NDNR gages in and near the study area. These data were used to determine the timing, frequency, rate of change, travel time, and magnitude of sub-daily flow and stage changes.

Field surveys were conducted at each of the ungaged sites to measure the topography using 9 to 10 closely spaced cross sections and flow parameters of top width and depth. Velocity measurements were not taken during the high flows experienced

in 2010 because a significant portion of the river was not wadeable. Data were collected at the ungaged sites for the following months:

- Site 3, Upstream of the Tailrace Return – May, August, and September 2010
- Site 4, Downstream of the Tailrace Return – June and September 2010
- Site 5, Near North Bend – July and September 2010

Objective 1: To compare the sub-daily Project hydrocycling operation values (maximum and minimum flow and stage) to daily values (mean flow and stage). In addition to same-day comparisons, periods of weeks, months, and specific seasons of interest to protected species will be evaluated to characterize the relative degrees of variance between hydrocycling (current operations) and run-of-river operations in the study area.

Task 2 Gage Analysis

A gage analysis was performed using existing USGS and NDNR flow and stage data from the listed gaged study sites to accurately determine the travel time, conveyance losses or gains, and magnitude of sub-daily flow attributable to Project hydrocycling. In addition, years with wet, dry, and normal hydrologic flow classifications were determined for each gaged and ungaged site based on an approach developed by Anderson and Rodney (October 2006). The period of analysis for this task was the period during which the NDNR gage of flows in the Tailrace Canal at the 8th Street bridge in Columbus has been in operation (2003 to 2009). The results of this analysis provide basic hydrologic information for use in subsequent tasks.

Task 3 Hydrographs for the Project versus Run-of-River Operations

Hydrographs of daily discharges for each gaged study site on the Platte River were plotted annually for the selected wet, dry, and normal years. From these plots, periods of weeks, months, and specific seasons of interest to protected species could be anlayzed. Daily maximum, minimum, and mean flows were plotted for each time interval. The annual synthetic hydrographs for current operations at the ungaged sites, as well as the annual synthetic hydrographs for run-of-river operations for the gaged and ungaged sites, were plotted in the same manner. The HEC-RAS models developed and calibrated for this hydrocycling study were used to approximate the stage hydrographs at the ungaged sites, and the most current rating curves were used to develop the stage hydrographs at the gaged locations.

Objective 2: To determine the potential for nest inundation due to both hydrocycling and alternative conditions.

Task 4 Nesting Season Sandbar Inundation Heights

Synthetic hydrographs developed under Objective 1, Task 3 for the years 2003 to 2009 were examined to compare theoretical instances of nest inundation under current operations and run-of-river operations. Only Site 4, downstream of the Tailrace Return, was evaluated because the flows at this location and Site 5, near North Bend, are similar in hydrograph shape and magnitude for both current and run-of-river operations. The highest synthetic sub-daily flow (benchmark flow) was identified between February 1, which was chosen as the beginning of the period to capture all potential late winter/early spring flows that occurred close enough to the nesting season to reasonably serve as the surrogate for highest potential nesting elevation each year, and the theoretical arrival of the species. This was assumed to be April 25 for piping plovers and May 15 for interior least terns. The benchmark flows were then compared to subsequent synthetic sub-daily flows at the ungaged sites for 2003 to 2009 from April 25 to July 31 (the nesting season for piping plovers) and from May 15 to August 15 (the nesting season for interior least terns) to determine the number of times the benchmark flow was exceeded. The number of times that theoretical inundation (exceedance of the benchmark flow) occurs under both current operations and run-of-river operations was compared to determine if Project hydrocycling operations increase or decrease the likelihood of potential nest inundation.

Objective 3: To assess effects, if any, of hydrocycling (current operations) and run-of-river operations on sediment transport parameters and channel morphology.

Task 5 Effects of Hydrocycling on Sediment Transport Parameters

Effects of hydrocycling on sediment transport parameters, which are direct indicators of the river morphology and habitat, were evaluated using the same methodologies, where applicable, outlined in Study 1.0, Sedimentation. Sediment transport indicators (effective and dominant discharges and total sediment transported, assuming transport at capacity) were determined for current operations and run-of-river operations using sub-daily hydrographs (developed in Task 3) to allow evaluation of the daily fluctuations under current operations and under run-of-river operations. The total sediment transport capacity and dominant discharge were calculated for both current and run-of-river operations for the selected wet, dry, and normal years.

Regime, spatial, and sediment transport analyses were also conducted. In regime analysis, the dominant discharges were plotted on Chang and Lane's regime morphology graphs in similar fashion to the procedure described in Study 1.0, Sedimentation. The spatial analysis, which included all of the ungaged sites, including Sites 3 and 4, was conducted as another way to evaluate Project effects on

sediment transport, as described in Study 1.0, Sedimentation. Finally, a sediment transport analysis for Sites 3, 4, and 5 was conducted using the USACE HEC-RAS model.

Objective 4: To identify material differences between hydrocycling (current operations) and run-of-river operations in potential effects on habitat of the interior least tern, piping plover, and pallid sturgeon.

Task 6 Effects of Hydrocycling on Interior Least Tern, Piping Plover, Pallid Sturgeon, and Isolation of Backwaters and Side Channels

The effects of manipulated flow operations on interior least tern and piping plover habitat, such as sandbars, and pallid sturgeon habitat, such as backwaters and side channels, on other rivers outside of the Project Boundary were examined and compared to current conditions on the lower Platte River resulting from Project operations. This comparison was used to determine if Project operations contribute to habitat conditions outside the spectrum of habitat used by these species on other river systems. River reaches used for comparison included the Red River below Denison Dam, the Arkansas River below Keystone Dam, the Missouri River reach below Fort Randall Dam, the Missouri River reach below Gavins Point Dam, and the Yellowstone River below Intake, Montana. These river reaches were chosen based on respective population census numbers and frequency of occurrence for the interior least tern, piping plover, and pallid sturgeon.

Habitat characteristics of the interior least tern, piping plover and pallid sturgeon associated with operations on these other rivers were identified for comparative analysis. This comparative analysis identified similarities or differences between Project operations and manipulated flow operations on the other rivers to assess the influence that the respective operations may have on habitat characteristics or species use.

The daily percentage of suitable habitat for pallid sturgeon was analyzed based on the discharge versus habitat relationship presented in Peters and Parham (2008), Chapter 10. The analysis included an evaluation of discharge for both current operations and run-of-river operations using the synthetic hydrographs developed for Objective 1. Discharges were evaluated for minimum, average, and maximum daily flows in years with wet, dry, and normal hydrologic flow classifications. All three discharges for both current operations and run-of-river operations were evaluated because of the natural variability of flows throughout the day that would occur under run-of-river operations. This allowed the District to evaluate the difference in available pallid sturgeon habitat under current operations and run-of-river operations.

The cross sections of the ungaged sites, taken during the pre-nesting and post-nesting time frame, were reviewed to identify changes in the cross sections, or river morphology. This included an evaluation of potential interior least tern and piping plover habitat as well as the change in flow area based on the data collection effort for

Objective 1. Because cross sections were obtained at locations both upstream and downstream of the Tailrace Return, this analysis provided an assessment of cross-section changes between locations unaffected and affected by hydrocycling that occurred in the 4 months between the two or three sets of measurements.

Finally, in addition to the literature review and other-river comparison, a steady-state one-dimensional (1-D) HEC-RAS model was developed for Sites 3, 4, and 5 to study the effects of hydrocycling on potential interior least tern and piping plover nesting habitat. Topographic and water surface elevation data collected in Task 1 were used to develop and calibrate the hydraulic models. Both current and run-of-river operations were modeled, and each model run was conducted for years with wet, dry, and normal hydrologic flow classifications. The parameters associated with interior least tern and piping plover nesting habitat that were evaluated by cross section are average channel width and percentage of exposed channel width.

2.4 RESULTS AND DISCUSSION

Objective 1: To compare the sub-daily Project hydrocycling operation values (maximum and minimum flow and stage) to daily values (mean flow and stage). In addition to same-day comparisons, periods of weeks, months, and specific seasons of interest to protected species will be evaluated to characterize the relative degrees of variance between hydrocycling (current operations) and run-of-river operations in the study area.

Hydrographs and water surface elevation graphs were plotted annually and seasonally for the selected wet, dry, and normal years. The effects of hydrocycling on the hydrograph are immediately apparent for the 2006 dry year. The difference between the maximum and minimum daily flows for current operations is larger than the difference between the maximum and minimum daily flows for run-of-river operations. These differences are reduced for the wet and normal years of 2008 and 2009, respectively. The average annual difference in water surface elevation between current operations and run-of-river operations is typically less than 1 foot. The natural seasonal flow variability is equal to or greater than the daily flow variability during operations unaffected by high flows.

Objective 2: To determine the potential for nest inundation due to both hydrocycling (current operations) and run-of-river operations.

The pre-nesting season benchmark flow for piping plovers was exceeded more often under run-of-river operations than under current operations for all years evaluated (2003 to 2009). For interior least terns, the benchmark exceedances were equal under both operating scenarios. For all exceedances for both species, there were no instances where current operations exceeded the benchmark flow, while run-of-river operations did not exceed the benchmark flow.

The pre-nesting season benchmark flows for both interior least terns and piping plovers for current operations ranged from 7,860 to 26,500 cubic feet per second (cfs), with an average benchmark flow of 13,716 cfs. The pre-nesting season benchmark flows for both species for run-of-river operations ranged from 5,910 to 25,900 cfs, with an average of 12,686 cfs. In general, the difference between pre-nesting season benchmark flows for current operations is, on average, 8.1 percent higher than that of run-of-river operations.

The nesting season peak maximum daily flow for both interior least terns and piping plovers for current operations ranged from 4,100 to 39,986 cfs, with an average peak flow of 18,985 cfs. The nesting season peak maximum daily flow for both species for run-of-river operations ranged from 3,213 to 35,533 cfs, with an average of 17,788 cfs. The nesting season peak maximum daily flow rate for current operations is, on average, 6.7 percent higher than that of run-of-river operations.

When evaluating the number of exceedances of the pre-nesting season benchmark (peak) flow, it was found that, for interior least terns, on average, the benchmark flow was exceeded 3.9 times per event under both current operations and run-of-river operations. For piping plovers, on average, the benchmark flow was exceeded 3.0 times per event for current operations and 3.1 times per event for run-of-river operations. Run-of-river operations had more distinct events for piping plovers that exceeded the pre-nesting season benchmark than current operations in 2003.

Objective 3: To assess effects, if any, of hydrocycling (current operations) on sediment transport parameters.

Using the methodology described in Appendix A, Sedimentation Study Report, dominant and effective discharges and total sediment capacity were calculated for Sites 3, 4, and 5 as well as the USGS gage at North Bend. These values were calculated for the selected wet, dry, and normal years as well as for the entire period from 2003 to 2009 using synthetic current operations and run-of-river operations sub-daily flows.

The results show that the run-of-river operations would transport less sediment, assuming all sediment is transported at capacity. The effective discharges for current operations are larger than the effective discharges for run-of-river operations. The dominant discharges are only slightly larger for current operations, by about 100 cfs. These differences in dominant and effective discharges would likely result in the channel area being smaller under run-of-river operations.

The results of the sediment transport modeling show that under each operating scenario, the system is transporting sediment at capacity. Because the system is flow limited and not supply limited, no degradation occurs under current operations.

Objective 4: To identify material differences between hydrocycling (current operations) and run-of-river operations in potential effects on habitat of the interior least tern, piping plover, and pallid sturgeon.

Comparison to Other Rivers

A review and comparison of habitat parameters, species counts, hydrocycling operations, and potential effects on interior least terns, piping plovers, and pallid sturgeon was conducted. Almost all other river reaches identified as important to interior least terns, piping plovers, and pallid sturgeon, based on population numbers, included large-scale dams and reservoirs with limited flow releases. Project operations are different from a large-scale dam in several ways. The Project includes a smaller degree of daily hydrocycling and no cold water releases. In addition, during times of high flow, these flows are bypassed and the Project does not divert water. Although daily hydrocycling occurs on most of these other rivers, limited information was found regarding the potential effect of this practice on the birds and fish and their associated habitat.

In these other river reaches, large releases to relieve flooding or reach navigation targets appear to have a measurable effect on interior least terns and piping plovers and their respective habitat. Furthermore, hypolimnetic releases[1] from the reservoirs behind each large dam can decrease temperature and turbidity downstream, potentially altering preferred pallid sturgeon habitat. The Project does not release water for flooding or navigation and does not have the capability to retain water for a prolonged period, such as these other dams do. Most other dams reviewed have large storage reservoirs and are able to release large quantities of water to meet electric generation or navigational needs, whereas the Project differs from a traditional dam in that it has no significant dam structure, no instream reservoir, and no project spillway. The Project's regulating reservoirs (Lake Babcock and Lake North) are used to provide capacity to pond water during low electrical demand hours of the day and release water during the high electrical demand hours of the day. During low electrical demand hours, flow through the Columbus Powerhouse normally drops to zero to maximize ponding. Maximum releases are 4,800 cfs during hours of peak electrical demand. Therefore, it is difficult to compare the Project's operations and habitat on the lower Platte River to these other, larger structures and the habitat that exists downstream on these larger rivers.

While studies in other rivers have not been conducted for the direct purpose of determining the effects of daily hydrocycling on interior least terns and piping plovers, changes in operations at Fort Randall Dam in accordance with conditions set forth in the USFWS amended Biological Opinion (BO) (December 16, 2003) have

[1] Hypolimnetic releases are releases of water from the hypolimnion, the layer of water in a thermally stratified lake that is the lowest and coldest layer.

shown that releasing at higher rates prior to the nesting season and during the early nesting season has encouraged the birds to nest at a higher elevation and prevented nest losses due to hydrocycling. Additionally, a study conducted by Leslie et al. (2000) on the effects of hydropower and flood-control operations of the Keystone Dam on the Arkansas River on interior least tern populations found that daily hydropower operations were not affecting the birds; however, subjecting nesting habitat to periodic high river flows prior to the nesting season could be beneficial because availability and quality of the habitat increased with flooding and population numbers expanded in a year following the flood. Because the Project does not have control over stopping or allowing large flood flows to affect the lower Platte River, the Project's effects from daily hydrocycling on sandbar formation are minor when compared to the effects from large flood flows.

Pallid sturgeon have been collected in reaches of the Missouri and Yellowstone rivers. Though precise habitat preferences of pallid sturgeon are not well known, surveys completed in the last decade suggest that pallid sturgeon select turbid, warm, flowing waters. In the upper Missouri River and the Yellowstone River, studies found that pallid sturgeon were located most commonly in areas with sandbars and sandy substrate (Bramblett and White, 2001; Tews, 1994). However, pallid sturgeon have been shown to use habitat with large ranges of characteristics (for example, temperature, flow, and depth) depending on what is available. The pallid sturgeon often selects from the best habitat available, not necessarily the most ideal habitat for the species (National Research Council, 2005; Elliot et al., March 2004; Jacobsen et al., 2009).

Percentage of Suitable Habitat

Using Peters and Parham's (2008) discharge versus habitat relationship for both current operations and run-of-river operations, the minimum yearly average percentage of suitable habitat available in the lower Platte River for a normal flow year increases consistently from a low of 1 percent above the Loup River confluence (near Duncan) to a maximum of 19 percent for current operations and 24 percent for run-of-river operations at Louisville. The increase in suitable habitat when moving downstream is consistent for minimum, maximum, and average daily flows for the selected wet, dry, and normal years. Overall, any differences in the availability of suitable habitat between current operations and run-of-river operations decrease when moving downstream.

Differences in the availability of suitable habitat between flows for current operations and run-of-river operations vary depending on the month of the year. Notable observations related to the monthly average percentage of suitable pallid sturgeon habitat are as follows:

- As with the yearly average, the percentage of suitable habitat increased when moving downstream for both current operations and run-of-river operations for each month.
- There was little to no (5 percent or less) suitable pallid sturgeon habitat above the Loup River confluence (near Duncan) throughout the year with the exception of May and June during the wet year, when as much as 16 percent suitable habitat was available above the Loup River confluence. The largest percentage of suitable habitat is available downstream of Louisville; during normal and wet years, minimum flows provided at least 12 percent suitable habitat for each month under both current operations and run-of-river operations. However, during August and September, minimum flows provided as little as 4 percent suitable habitat under current operations and 10 percent under run-of-river operations.
- During dry years, the lower Platte River upstream of the Elkhorn River confluence (upstream of the Ashland gage) provided little to no suitable habitat during the summer months (May to August) under both current operations and run-of-river operations.
- The months of February through June exhibit the greatest habitat availability for nearly all downstream sites, especially for normal and wet years.

Peters and Parham (2008) reported that pallid sturgeon captures most often occurred in the deepest and swiftest areas of the Platte River and that these habitat types were used more frequently than would be expected if used at random. On the Platte River, radio telemetry data further suggest that pallid sturgeon were typically found in depths ranging from 2 to 5.9 feet and average bottom velocities that ranged from 0.6 to 1.9 feet per second (Peters and Parham, 2008). The Lower Platte River Stage Change Study (HDR et al., December 2009) suggested that changes in habitat availability as a result of a change in discharge, assuming rigid-bed boundaries, would have a negligible influence on pallid sturgeon habitat in the lower Platte River below the confluence of the Elkhorn River.

HEC-RAS Model Results

The results of the 1-D HEC-RAS model were used to determine variations in potential nesting habitat under current operations and run-of-river operations for the selected wet, dry, and normal years based on a maximum daily flow at both Sites 4 and 5 for low-, medium-, and high-flow conditions. Site 3 was used as a control and compared

to Site 4 under current operations in order to note any differences. The following summarizes the results of this analysis:

- Site 3:
  - The average channel width (as measured from bank to bank) showed very little change between the June and September cross sections (1,071 and 1,077 feet, respectively).
  - The percentage of exposed channel width decreased from dry to wet years. This is to be expected because it is a property of rigid-boundary hydraulics for the exposed channel width in any irregular boundary channel to decrease with rising stages.
  - When compared to Site 4, Site 3 exhibited, on average, a higher percentage of exposed channel width during the dry year, but less exposed channel width than Site 4 during the normal and wet years, under current operations. When comparing Site 3 to Site 4 under run-of-river operations, in the dry year, both sites exhibit a similar percentage of exposed channel width; however, in the normal and wet years, Site 4 has a higher percentage of exposed channel width than Site 3 under run-of-river operations.
- Site 4:
  - The average channel width was relatively constant for both the June and September cross sections (1,726 and 1,723 feet, respectively).
  - The percentage of exposed channel width generally decreased from the dry year (2006) to normal year (2009) to wet year (2008) for both June and September cross sections for both current operations and run-of-river operations.
  - The percentage of exposed channel width generally decreased from low- to medium- to high-flow conditions. This would be expected, given that channels will show a decrease in exposed channel width for higher discharge rates and wetter conditions.
  - The run-of-river operations generally had a higher percentage of exposed channel width than exhibited under current operations, and the June cross sections yielded a higher percentage of exposed channel width than did the September cross section (with the exception of the medium-flow condition for the normal year [2009]).

- Site 5:
    - The average channel width was relatively constant for both the June and September cross sections (1,610 and 1,604 feet, respectively); however, when compared to Site 4, the channel begins to narrow in this area (1,600 feet at Site 5 compared to 1,700 feet at Site 4).
    - The percentage of exposed channel width was greatest under the dry year (2006) and decreased under the normal (2009) and wet (2008) years, respectively, under both current operations and run-of-river operations.
    - The run-of-river operations generally had a higher percentage of exposed channel width than exhibited under current operations.

No consistent trend in percentage of exposed channel width is evident between Sites 4 and 5. At all sites, there is generally a higher percentage of exposed channel width under run-of-river operations than under current operations. The cause of this decrease in exposed channel width under current operations is likely that the duration of higher-than-average flows during days with hydrocycling compared to the duration on the same days of lower-than-average flows resulted in an accumulation of time when higher overall water levels prevailed, thereby causing overall reduced exposed widths, which would always be true for a rigid-boundary channel.

SECTION 3 STUDY 3.0, WATER TEMPERATURE IN THE PLATTE RIVER

Consistent with the District's RSP (Loup Power District, July 27, 2009) and FERC's Study Plan Determination (FERC, August 26, 2009), Study 3.0, Water Temperature in the Platte River, has been removed from the suite of studies that the District is performing in association with Project relicensing.

The study was originally introduced in the District's PSP to address agency concerns with Project effects on pallid sturgeon related to water temperature. The primary concern was related to how changes in water temperature might affect the spawning and migration cues of the species. However, during the April 21, 2009, Study Plan Meeting, it was decided by attending agencies that the study (as defined in the District's PSP) could not be successful in isolating Project effects and is not necessary to facilitate Project relicensing.

The discussion at the April 21, 2009, Study Plan Meeting focused on the following variables that would be too great to overcome in attempts to isolate Project effects on water temperature in the lower Platte River:

- Tributaries

  Multiple tributaries contribute flow to the Platte River between the Tailrace Canal and USGS Gage 06805500, Platte River at Louisville, NE. These tributaries include the Elkhorn River, Salt Creek, Buffalo Creek, and Shell Creek. These multiple inflows provide significant variability that would complicate the isolation of Project effects on water temperature in the lower Platte River.

- Lag Time

  Discharge from the Tailrace Canal travels approximately 80 miles before reaching USGS Gage 06805500, Platte River at Louisville, NE. On average, the travel time of flows for this distance is 2 to 3 days. This amount of time allows for significant attenuation of Project effects. The lag time coupled with the inflows of multiple tributaries makes it extremely difficult to isolate Project effects.

- Dominant Atmospheric Effects

  Preliminary evaluation of temperature data at USGS Gage 06805500, Platte River at Louisville, NE, indicated that the overriding influence on water temperature appears to be related to solar radiation and atmospheric influences, with no obvious influence from the Project.

SECTION 4 STUDY 4.0, WATER TEMPERATURE IN THE LOUP RIVER BYPASS REACH

4.1 GOALS AND OBJECTIVES OF STUDY

The goal of the study of water temperature in the Loup River bypass reach is to determine if Project operations (flow diversion) materially affect water temperature in the Loup River bypass reach (with particular emphasis on the Loup River bypass reach between the Diversion Weir and the confluence of Beaver Creek with the Loup River) or in the reach of the Platte River between the Loup River confluence and the Tailrace Canal.

The objectives of the study of water temperature in the Loup River bypass reach are as follows:

1. To estimate the relationship between flow in the Loup River bypass reach, ambient air temperature, water temperature, relative humidity, and solar radiation.
2. To describe and quantify the relationship, if any, between diversion of water into the Loup Power Canal and water temperature in the Study Reach of the Loup River bypass reach.
3. To determine if water temperature standard exceedances occur in the reach of the Platte River between the Loup River confluence and the Tailrace Canal.

4.2 STUDY AREA

The study area includes the entire Loup River bypass reach, the entire reach of the Platte River between the Loup River confluence and the Tailrace Canal, and a small reach of the Platte River just upstream of the Loup River confluence.

There are five study sites within the study area where water temperature data were collected:

- Loup River on the upstream side of the Diversion Weir
- USGS Gage 06793000, Loup River near Genoa, NE
- NDNR Gage 06794500, Loup River at Columbus, NE
- Reach of the Platte River between the Loup River confluence and the Tailrace Canal
- Platte River upstream of the Loup River confluence

In addition, USGS Gage 06792500, Loup River Power Canal near Genoa, NE, was used to estimate flow in the Loup River just upstream of the Diversion Weir.

4.3 METHODOLOGY

The methodology for the study of water temperature in the Loup River bypass reach and the reach of the Platte River between the Loup River confluence and the Tailrace Canal includes three tasks, described below.

Task 1 USGS Coordination

The District coordinated with USGS on the successful installation of temperature sensors at two locations: 1) Loup River at the Diversion Weir (USGS Gage 06792490, Loup River at Merchiston, NE) and 2) USGS Gage 06793000, Loup River near Genoa, NE. Data logged by both sensors are available online at the following addresses:

- USGS Gage 06792490, Loup River at Merchiston, NE – http://waterdata.usgs.gov/nwis/uv/?site_no=06792490
- USGS Gage 06793000, Loup River near Genoa, NE – http://waterdata.usgs.gov/nwis/uv?cb_00060=on&cb_00045=on&cb_00065=on&cb_00010=on&format=gif_default&period=60&site_no=06793000

Task 2 Data Collection

Flow data collection (from the Loup River near Genoa and from the Loup River Power Canal near Genoa) began on May 1, 2010 and continued through September 2010. Ambient air temperature data from the National Weather Station at Genoa were also collected. The data were organized in a database by day, week, and month, and data gaps were identified and described. The descriptive statistics add-in available in Microsoft Excel was used to provide descriptive statistics, such as count, maximum, mean, minimum, and standard deviation, for the grouped data.

As a result of the successful implementation of Task 1 (see above), temperature data collection began at the Loup River at Merchiston on May 3, 2010, and at the Loup River near Genoa on May 5, 2010; data collection continued through September 30, 2010. It should be noted that the temperature sensor installed at the Loup River near Genoa was washed away by high flows on June 10, 2010. A replacement sensor was installed on July 19, 2010. Consequently, a data gap exists from June 10, 2010 to July 20, 2010, at this location only.

To check the variability of the instrumentation used to collect August 2010 temperature data from the Loup River at Columbus and the Platte River, two temperature data loggers were installed at each of the following locations: adjacent to the Loup River near Genoa and adjacent to the newly installed temperature probe at the Diversion Weir. Prior to actual data collection implementation, data were logged via the proposed instrumentation from June 2, 2010 to June 9, 2010, and were compared to USGS data outputs to ensure accuracy.

August temperature data were collected via temperature data loggers from August 13 to August 23 at the following sites:

1. The Loup River at Columbus, coincident with NDNR Gage 06794500, Loup River at Columbus, NE[1]
2. The reach of the Platte River between the Loup River confluence and the Tailrace Canal
3. The Platte River upstream of the Loup River confluence

A percent probability of exceedance analysis similar to the Sinokrot and Gulliver method was used to evaluate whether temperatures measured at these locations exceeded the Nebraska Department of Environmental Quality temperature standard of 90˚F (32˚C) and, if so, how often and by how much.

Task 3 Data Analysis

Data were plotted and regressions determined to identify general patterns and to distinguish trends, as outlined in the District's RSP and as necessary to satisfy the goals and objectives of the study. Additionally, applicable plots were performed relative to temperature exceedances in the reach of the Platte River between the Loup River confluence and the Tailrace Canal.

A predictive relationship was established and could potentially be used to predict during what conditions the water quality temperature standard may be exceeded.

4.4 RESULTS AND DISCUSSION

Study results are summarized below by study objective.

Objective 1: To estimate the relationship between flow in the Project bypass reach, ambient air temperature, water temperature, relative humidity, and solar radiation.

Water temperature within the Loup River bypass reach fluctuates on a synchronous daily cycle at both the Merchiston and Genoa stations regardless of discharge conditions. This suggests that the parameter influencing water temperature also varies on a daily basis. After no significant relationship was determined between flow and water temperature, relative humidity, or radiative flux, air temperature was determined to be the most influential parameter.

Objective 2: To describe and quantify the relationship, if any, between diversion of water into the Loup Power Canal and water temperature in the Project bypass reach.

Water temperature data collected in the Platte River (both upstream of the Loup River confluence and in the Platte River bypass reach) displayed higher hourly mean

[1] NDNR reinstated this gage in 2008 at the same location as former USGS Gage 06794500, Loup River at Columbus, NE.

temperatures compared to temperatures at the Loup River sampling locations (Genoa and Columbus). Further analysis concluded that the higher flows, and associated water temperature, supplied by upstream Platte River flows more greatly influence the water temperature of the Platte River bypass reach than the flows contributed by the Loup River. That is, the diversion of Loup River flows by the District is not the driver behind higher water temperatures within the Platte River between the Loup River confluence and the Tailrace Return.

Objective 3: To determine if a "critical reach" relative to water temperature excursions exists within the Project bypass reach.

The reaches of the Loup River between Genoa and Columbus exhibited very similar water temperatures during May, June, and August 2010. Based on these findings, no critical reach relative to thermal stress and potential fish kills within the Loup River bypass reach was determined. However, the data show that water temperature in the Loup River near Genoa might exceed the standard more often than water temperature in the Loup River at Columbus.

Objective 4: To determine if an accurate and reasonable method exists for predicting water temperature excursion events.

Study investigations determined that July and August water temperature excursions in the Loup River near Genoa can be predicted, with some accuracy, based on the exceedance of an identified morning air temperature threshold at Monroe. That is, when the air temperature at Monroe is at least 74˚F by 8:00 a.m., a water temperature excursion in the Loup River near Genoa is likely to occur later in the same day.

SECTION 5 STUDY 5.0, FLOW DEPLETION AND FLOW DIVERSION

5.1 GOALS AND OBJECTIVES OF STUDY

The goals of the flow depletion and flow diversion study are to determine if Project operations result in flow depletion on the lower Platte River and to what extent the magnitude, frequency, duration, and timing of flows affect the Loup River bypass reach. The results were used to determine if Project operations (current operations) relative to flow depletion and flow diversion adversely affect the habitat used by interior least tern and piping plover populations, the fisheries, and the riverine habitat in the Loup River bypass reach and the lower Platte River compared to an alternative condition (the no diversion condition). No diversion was defined as no water being diverted into the Project but does not represent a case of Project decommissioning. Potential Project effects on whooping crane roosting habitat were an added concern of USFWS after submittal of the District's RSP on July 27, 2009. This species and its associated roosting habitat were included in FERC's Study Plan Determination, and an additional objective was developed to address potential Project effects on this species (see Objective 7, below).

The objectives of the flow depletion and flow diversion study are as follows:

1. To determine the net consumptive losses associated with Project operations compared to the no diversion condition.
2. To use current and historic USGS gage rating curves to evaluate change in stage in the Loup River bypass reach during Project operations and compare against hydrographs of a no diversion condition.
3. To evaluate historic flow trends on the Loup and Platte rivers since Project inception.
4. To determine the extent of interior least tern and piping plover nesting on the Loup River above and below the Diversion Weir.
5. To determine Project effects, if any, of consumptive use on fisheries and habitat on the lower Platte River downstream of the Tailrace Canal.
6. To determine the relative significance of the Loup River bypass reach to the overall fishery habitat for the Loup River.
7. To determine the availability of potential whooping crane roosting habitat above and below the Diversion Weir under Project operations compared to the no diversion condition.

5.2 STUDY AREA

The study area includes the Loup Power Canal and associated regulating reservoirs; the Loup River bypass reach, which begins at the Diversion Weir, located west of Genoa, and ends at the confluence with the Platte River at Columbus; and the lower Platte River from the confluence with the Loup River to the USGS gage at North Bend. The following existing stream gage locations in the study area served as study sites for analyses:

- USGS Gage 06793000, Loup River near Genoa, NE
- USGS Gage 06794500, Loup River at Columbus, NE

In addition to these study sites, FERC, in its Study Plan Determination dated August 26, 2009, required that "ungaged" sites also be evaluated. The approved methodology for the flow depletion and flow diversion study included a provision that cross-section surveys and calculations of sediment transport indicators be conducted at three ungaged sites. The approved methodology for the sedimentation and the hydrocycling studies included a provision that cross-section surveys and calculations of sediment transport indicators be conducted at two additional ungaged sites. The ungaged sites were chosen in consultation with USFWS and NGPC through the use of aerial photographs. The five ungaged sites and the studies with which they are associated are listed below; the three ungaged sites relevant to this flow depletion and flow diversion study are Sites 1, 2, and 3:

1. Loup River upstream of the Diversion Weir (Site 1) – Sedimentation and flow depletion and flow diversion
2. Loup River immediately downstream of the Diversion Weir (Site 2) – Flow depletion and flow diversion
3. Lower Platte River downstream of the Loup River confluence and upstream of the Tailrace Return confluence (Site 3) – Sedimentation, hydrocycling, and flow depletion and flow diversion
4. Lower Platte River within 5 miles downstream of the Tailrace Return confluence (Site 4) – Sedimentation and hydrocycling
5. Lower Platte River near the USGS North Bend gage (Site 5) – Hydrocycling

5.3 METHODOLOGY

The methodology for the flow depletion and flow diversion study includes seven tasks designed to meet the six objectives presented in Section 5.1, Goals and Objectives of Study. The objectives are repeated below, followed by the tasks conducted to meet each objective. Task 1, Data Collection, however, is required prior to initiation of the other tasks and is not associated with one specific objective. The period of analysis varies by task.

Task 1 Data Collection

Flow and stage data were collected for each study site. This included all available flow data for the period of record along with the current and historic rating curves.

As specified in FERC's Study Plan Determination, cross section information was to be obtained during low flow conditions and at a higher flow. The range of low flow and high flow dates selected for the cross section surveys of the ungaged sites were based on historic hydrographs at the gaged locations and discussions with USFWS and NGPC. It was determined that high flow data would be collected in late April to early May and that low flow data would be collected in late July to early August. Cross section information for the Loup River downstream of the Diversion Weir was obtained on April 15, 2010. Cross section information for the lower Platte River downstream of the Loup River confluence and upstream of the Tailrace Return confluence was obtained during the week of May 3, 2010. However, the data collection was very difficult at the lower Platte River site due to high flows and high winds as a result of storm events. Cross section information for the Loup River upstream of the Diversion Weir was unobtainable during the first week of May due to continued storm events causing widespread sandbar inundation and high winds. Instead, this survey information was collected on June 2 and 3, 2010. Similarly, the topographic surveys required at the same sites during the first week of August 2010 were also delayed due to continued high flows and the observation of nesting interior least terns and piping plovers within the study reach. Therefore, the data will be collected when interior least tern and piping plover nesting ends and flows return to normal levels.

Available atmospheric data, including pan evaporation, precipitation, and temperature, will be obtained from National Weather Service stations for the years 1980 through 2009. This range of data was selected because it includes a moderate flow period (1980 to 1992), two wet periods (1993 to 1998 and 2007 to 2009), and a dry period (1999 to 2006). In addition, soil survey data and aerial and satellite images of the vegetation along the Loup River bypass reach will be obtained for the years 1980 through 2009.

Objective 1: To determine the net consumptive losses associated with Project operations compared to alternative conditions

Objective 5: To determine Project effects, if any, of consumptive use on fisheries and habitat on the lower Platte River downstream of the Tailrace Canal.

Task 2 Net Consumptive Use

Net consumptive use was calculated for the Loup Power Canal and Loup River bypass reach for current Project operations and no diversion conditions for the years 1980 through 2009. Consumptive use losses were calculated by adding open water

evaporative losses and evapotranspiration (ET) losses from native vegetation and agricultural crops.

Consumptive Use in the Loup Power Canal and Associated Regulating Reservoirs

Consumptive use in the Loup Power Canal and associated regulating reservoirs were calculated on a monthly and seasonal basis by adding the ET consumptive use losses and the evaporation consumptive use losses.

As directed in FERC's Study Plan Determination, consumptive losses associated with the irrigation withdrawals were determined. This was done by evaluating the District's gage records, soil type, and crop irrigation demand.

Consumptive Use in the Loup River Bypass Reach

Consumptive use in the Loup River bypass reach was calculated on a monthly and seasonal basis by adding the ET consumptive use losses and the evaporation consumptive use losses.

Consumptive losses due to ET from the trees and other large vegetation bordering the Loup River bypass reach were calculated by tabulating the length of riparian vegetation bordering the bypass reach (observed from aerial photographs and satellite images) and estimating an ET rate per unit length.

Net Consumptive Use

The net consumptive use was estimated by taking the difference between the consumptive use losses in the Loup Power Canal and regulating reservoirs and the consumptive use losses in the Loup River bypass reach. Values were estimated on a monthly, seasonal, and annual basis for the period 1980 through 2009 for current Project conditions and alternative conditions.

Objective 2: To use current and historic USGS gage rating curves to evaluate change in stage in the Loup River bypass reach during Project operations and compare against alternative hydrographs.

Task 3 Flow Duration and Flood Frequency Curves

Existing gage data was used to develop flood frequency and flow duration curves in the Loup River bypass reach for current Project operations. Flood frequency and flow duration curves were created for the gaged locations for the period of record. The USGS gage on the Loup River at Columbus was discontinued in 1978. Therefore, the relationship between the Loup River near Genoa and the Loup River at Columbus that was developed by USFWS (May 15, 2002) was incorporated for this study.

Synthetic hydrographs for the ungaged sites were developed and plotted for current Project operations from 2003 to 2009. Conveyance losses or gains were estimated for current operations based on existing gage data (Task 2). Flood frequency and flow duration curves were developed based on the synthetic hydrographs for the ungaged

sites for current Project operations. Synthetic hydrographs will be developed for a no-diversion condition. The conveyance losses or gains determined from current operations will be applied for the gaged and ungaged sites to develop the no-diversion synthetic hydrographs. Flow duration and flood frequency were determined for the no-diversion condition. The results of this analysis were used for subsequent tasks. The flood frequency and flow duration curves were developed using the USACE modeling package HEC-SSP.

An analysis was performed to determine wet, dry, and normal flow years for each gaged and ungaged site using methodology outlined in Anderson and Rodney (October 2006). The period of analysis for this task was the period during which the NDNR gage of flows in the Tailrace Canal at the 8th Street bridge in Columbus has been in operation (2003 to 2009).

Task 4 Stage

The stage in the Loup River bypass reach at Genoa and Columbus was evaluated using current and historic USGS rating curves and the results from Task 3, Flow Duration and Flood Frequency Curves. The stage for Project operations was compared with the stage for alternative conditions to obtain change in stage for the 25, 50, and 75 percent chance exceedance discharges for the time period of 1980 through 2009.

Objective 3: To evaluate historic flow trends on the Loup and Platte rivers since Project inception.

Task 5 Loup River and Platte River Depletions

Historic flow records will be evaluated to determine the general flow trend (increasing, decreasing, or relatively constant) in the Loup and Platte rivers. USGS gages on the Loup River at Genoa and Columbus and USGS gages on the Platte River at Duncan and North Bend will be evaluated. A USGS report (Ginting, Zelt, and Linard, 2008) and other similar reports will be used to assess flow depletions in the Platte River. This information was used as the baseline to evaluate Project-related effects.

Objective 4: To determine the extent of interior least tern and piping plover nesting on the Loup River above and below the Diversion Weir.

Task 6 Interior Least Tern and Piping Plover Nesting on the Loup River Bypass Reach

Existing information from NGPC on interior least tern and piping plover nesting activities upstream and downstream of the Diversion Weir on the Loup River has been collected. As part of this objective, nest occurrence above the Diversion Weir was compared to nest occurrence below the Diversion Weir to the Tailrace Return to determine if significant differences exist. The review of nesting data was inconclusive; therefore, aerial photography for five randomly selected river miles

within the riparian corridors along the bypass reach (approximately 36 river miles downstream of the Diversion Weir) and for five randomly selected river miles within approximately 35 miles upstream of the Diversion Weir are being examined to identify and compare the following habitat parameters using a similar methodology as used by Kirsch (1996):

- number, position, and average size of bare sand areas within the banks of the river
- channel width
- percent un-vegetated sandbars
- percent vegetated sandbars (isolated and non-isolated)
- presence and/or type of vegetation.

The observed conditions for each year for these parameters was compared to determine to what extent flow diversion and the presence of the Diversion Weir may result in different river and riparian vegetation conditions. Observed habitat parameters (listed above) on the Loup River will be compared to species habitat requirements to determine if any changes in the riparian corridor may have had an effect on the occurrence of these species.

Finally, as directed in FERC's Study Plan Determination, a modeling study is being conducted to determine the effects of diverted flows on interior least tern and piping plover nesting habitat and whooping crane roosting habitat using the steady-state 1-D HEC-RAS backwater model. The study sites are the ungaged sites listed in Section 5.2, Study Area, which were selected based on coordination with USFWS and NGPC. Topographic data listed in Task 1 was used to develop the model. The model was run to model existing and no-diversion conditions. Each model run was conducted for a wet, dry, and normal flow year. The following parameters associated with interior least tern and piping plover nesting habitat were evaluated by cross section:

- Width of exposed sandbar
- Wetted width of sandbars
- Channel widths

Objective 6: To determine the relative significance of the Loup River bypass reach to the overall fishery habitat for the Loup River.

Task 7 Fishery Populations Above and Below the Diversion Weir

Data collected during 1996 and 1997 NGPC fish sampling efforts on the Loup River were used to analyze fish populations above and below the Diversion Weir (NGPC, June 1997 and April 1998).

The District's RSP indicated that flow information from Task 3 would be used to calculate the opportunity for fish species to migrate upstream of the Diversion Weir during high flows when the Diversion Weir is submerged or the Sluice Gates are opened. Specific analysis of the flows from Task 3 was not conducted. Instead, the results from Study 7.0, Fish Passage, are summarized.

Task 8 Montana Method

As directed in FERC's Study Plan Determination, mean annual flows were determined for the Loup River immediately upstream of the Diversion Weir and for the lower Platte River immediately downstream of the confluence with the Loup River. Based on the computed mean annual flows, the various percentages of mean annual flow were computed and used to describe fish habitat in the Loup River bypass reach and lower Platte River based on the Montana Method (Tennant, 1976).

Objective 7: To determine the availability of potential whooping crane roosting habitat above and below the Diversion Weir under Project operations compared to the no diversion condition.

Task 9: Whooping Crane Roosting Habitat Evaluation on the Loup River Bypass Reach

An aerial imagery review was conducted to identify potentially available whooping crane roosting habitat above and below the Diversion Weir.

Prior to conducting the aerial imagery review, a literature review was conducted to identify potential roosting habitat parameters for whooping cranes. Habitat parameters evaluated in the aerial imagery review relating to whooping crane roosting habitat were as follows:

- Channel width
- Average area of shallow water/wet sand[1] per river mile
- Percentage of shallow water/wet sand areas
- Unobstructed channel width

Unobstructed channel width, as a measure of horizontal visibility, was calculated as the distance across a channel between visual obstructions. For the purposes of this flow depletion and flow diversion study, visual obstructions are defined as either a bank and/or perennial vegetation whose combined height is greater than 3 feet (Farmer et al., 2005).

[1] The classifications of shallow water and wet sand could not be separated because pixel coloration for these two features was very similar and difficult to classify. Depth of the water could not be determined from the aerial interpretation; therefore, water with a darker pixel shade was classified as deep water, and water or sand with a lighter pixel shade was classified as shallow water/wet sand.

In addition to the aerial interpretation, a steady-state 1-D HEC-RAS model was used to evaluate whooping crane roosting habitat as directed in FERC's Study Plan Determination.

The model results were used to study the effects of diverted flows on potential whooping crane roosting habitat. During the January 5, 2010 meeting with USFWS and NGPC, the agencies identified the same model parameters (relationship among discharge and unobstructed channel width, total wetted width, distance to visual obstructions, and cumulative depth) as being important for determining effects on whooping crane roosting habitat. The model is limited in the amount of information that could be obtained. However, the model is able to provide estimates of the percentage of channel width (calculated as high bank to high bank) with water depths of 0.8 foot or less as it relates to whooping crane roosting habitat (wetted sand areas within the channel banks with water depths of 0.8 foot or less), so this was identified as an indicator of whooping crane habitat. In this case, high bank to high bank channel width (referred to hereafter as channel width) was used instead of wetted width because the channel width metric does not change with the different flow conditions and made it easier to compare the identified habitat parameter from year to year and under different flow conditions.

The percentage of channel width with a depth of 0.8 foot or less was evaluated at 25 (high-flow), 50 (medium-flow), and 75 (low-flow) percent exceedance flows to determine the effects on this indicator based on a variety of flow levels. Additionally, representative wet, dry, and normal years and mean daily flows were evaluated against the percentage of channel width with a depth of 0.8 foot or less. Cross sections were taken in either late spring or early summer and in either late summer or early fall.

Once calibrated, the model was executed for both current operations and the no diversion condition. For each cross section within a study site, the amount of channel width (bank to bank) that had depths of 0.8 foot or less was determined. A percentage of this amount was calculated based on the total channel width at that cross section. These percentages were summed, and then the average for the study site was determined. This process was conducted for each flow scenario for both current operations and the no diversion condition. This analysis was conducted for only the early summer (June) cross section because this time frame relates best to conditions during a period when the whooping crane is migrating through the region; however, whooping cranes also migrate through Nebraska in the fall.

5.4 RESULTS AND DISCUSSION

Objective 1: To determine the net consumptive losses associated with Project operations compared to the no diversion condition.

The consumptive loss analysis shows that flow depletions under current operations are less than would occur under the no diversion condition. Therefore, it is concluded

that Project operations do not adversely impact fisheries and aquatic habitat relative to flow depletions.

Objective 2: To use current and historic USGS gage rating curves to evaluate change in stage in the Loup River bypass reach during Project operations and compare against hydrographs of a no diversion condition.

The increase in flow in the bypass reach between current operations and the no diversion condition results in an increase in stage, which is to be expected. In general, the magnitude of the stage change decreases for higher flows. In addition, both the flow and associated stage change are greater under a dry year classification than a wet year classification.

Objective 3: To evaluate historic flow trends on the Loup and Platte rivers since Project inception.

The long-term historic trends indicate that annual Platte River flows upstream (at Duncan) and downstream (at North Bend and Louisville) of the Loup River confluence have been well-documented as increasing throughout the period that the Project has been in operation. As shown in two USGS reports (Ginting, Zelt, and Linard, 2008; Dietsch, Godberson, and Steele, 2009) and additional analyses by the District, no adverse flow impacts of Project operations are evident. Although flows are highly fluctuating and cyclic, this natural positive long-term trend in flows is statistically significant and, according to USGS, is attributed largely to natural climatic cycling. The positive trend should be neither credited to nor charged against the Project because the Project does not impact flows at Duncan, yet the same trends identified at Duncan also occur downstream.

Objective 4: To determine the extent of interior least tern and piping plover nesting on the Loup River above and below the Diversion Weir.

The comparison of nesting occurrences of interior least terns and piping plovers above and below the Diversion Weir yielded inconclusive results. Because of the small sample size and limited dataset, it was concluded that data were insufficient to accurately determine if there is a significant difference between nesting occurrences above and below the Diversion Weir.

However, the aerial imagery review of interior least tern and piping plover habitat parameters above and below the Diversion Weir yielded detectable differences in the measured parameters (number of sandbars, channel widths, average size of the sandbars, and location of sandbars). On average, there are more sandbars per river mile above the Diversion Weir but these sandbars are smaller than sandbars below the Diversion Weir. The channel widths (high bank to high bank) are wider above the Diversion Weir and become approximately 400 feet narrower below the Diversion Weir. In general, there is a higher percentage of vegetation on sandbars located below the Diversion Weir, although all average vegetation percentages were less than 21

percent and within the range of acceptable vegetation percentages for nesting interior least terns and piping plovers.

Sandbars below the Diversion Weir, likely due to their larger size, also had a higher percentage of bare sand and a larger bare sand area than sandbars above the Diversion Weir. Most sandbars located below the Diversion Weir are point bars and located along the riverbanks, while, on average, a greater percentage of mid-channel bars exist above the Diversion Weir.

The comparison above and below the Diversion Weir under current operations and the no diversion condition using the 1-D HEC-RAS model determined that, on average and as expected, the percentage of exposed channel width was generally greater under current operations below the Diversion Weir during all flows and all years. The percentage of exposed channel width above the Diversion Weir ranged from 38 percent of the channel width under low flows in a dry year to 2 percent of the channel width under high flows in a wet year. The percentage of exposed channel width below the Diversion Weir under current operations ranged from 87 percent of the channel width under low flows in a dry year to 10 percent of the channel width under high flows in a wet year. Below the Diversion Weir under the no diversion condition, the percentage of exposed channel width was similar to percentages above the Diversion Weir and ranged from 26 percent of the channel width under low flows in a dry year to 3 percent of the channel width under normal and high flows in a wet year.

Objective 5: To determine Project effects, if any, of consumptive use on fisheries and habitat on the lower Platte River downstream of the Tailrace Canal.

Because there are no measurable flow depletions to the lower Platte River (see Objective 1), fisheries and habitat are not adversely impacted to a greater extent under current operations than they would be under the no diversion condition.

Objective 6: To determine the relative significance of the Loup River bypass reach to the overall fishery habitat for the Loup River.

The 1996 and 1997 NGPC fish sampling efforts indicate that similar species of fish exist in the reaches both above and below the Diversion Weir. The population structures for the reaches above and below the Diversion Weir are also similar, with similar sport fishery populations. In both 1996 and 1997, more fish were collected in the reach below the Diversion Weir than in the reach above the Diversion Weir.

With respect to fish passage over the Diversion Weir or via the Sluice Gates, Study 7.0, Fish Passage, determined that the Diversion Weir is submerged and provides a potential pathway for upstream migrating fish during less than 1 percent of the spawning season (defined as April through June for this analysis). During the 1 percent of the spawning season in which the Diversion Weir is submerged, the resulting flow velocities over the Diversion Weir are higher than the critical swimming speeds of all analyzed fish species. Additionally, when the Sluice Gate

Structure is open, average flow velocities through the structure are too great to allow fish passage.

However, it is acknowledged that fish passage is occurring and is likely the result of lower velocities near boundary layers near solid surfaces and hydraulic shadows associated with hydraulic structures, particularly at the interface of corners of the wall and floor. The velocity in these areas is very slow compared to the calculated average velocity through the gate. A fish could work its way up near the gate, rest in a hydraulic shadow, and then burst through, following the concrete along the gate housing. This type of behavior has been documented at hydraulic structures on the Mississippi River (USACE, May 2000). Given these hydraulic conditions and the known species diversity above and below the Diversion Weir, fish passage is likely occurring at the Project Headworks, particularly by larger and stronger adult fish.

The Montana method provided the following habitat assessment for the Loup River:

- Site 1 – Upstream of the Diversion Weir
  - Higher average of "Satisfactory[2]" ratings than the Loup River near Genoa gage
  - Less than "Satisfactory" rating in July, August, and September
  - No months during any of the years in the period of record were rated as "Degraded"
  - No conditions under "Satisfactory" from October through March
- Loup River near Genoa gage
  - Fewer years within the "Satisfactory" range than Site 1, particularly in July, August, and September
  - A majority of "Poor" and "Degraded" flows during the period of record in July, August, and September
  - Fewer months during the period of record with degraded flows occurred in October through March than in April through September (There were years with degraded stream flows during October, but these were reduced considerably from November until March.)

The Montana method provided the following habitat assessment for the Platte River:

- Platte River near Duncan gage
  - Degraded flows in July, August, and September
  - A large majority of "Satisfactory" ratings for all other months

[2] Satisfactory ratings were considered ratings of Good, Excellent, Outstanding, or Optimum.

- Site 3 – Upstream of the Tailrace Return
  - Degraded flows in July, August, and September
  - A large majority of "Satisfactory" ratings for all other months
  - Fewer years with "Degraded" ratings than the Platte River near Duncan gage

Based on this assessment for the Platte River, it appears that most months are meeting adequate flow requirements for satisfactory biological conditions. July, August and September are the only months where the Platte River has a "Poor" or "Severely Degraded" rating. However, because the Platte River near Duncan gage also exhibits the same (or slightly worse) ratings, flow depletions are likely due to other upstream causes or natural seasonal fluctuations in water availability and are not readily attributed to Project operations.

Objective 7: To determine the availability of potential whooping crane roosting habitat above and below the Diversion Weir under Project operations compared to the no diversion condition.

The aerial imagery review of whooping crane habitat parameters above and below the Diversion Weir yielded detectable differences in the measured parameters (channel widths, shallow water/wet sand areas, and unobstructed channel widths). Greater areas of shallow water/wet sand were located below the Diversion Weir, while above the Diversion Weir, there were less areas of shallow water/wet sand, which is a preferred roosting characteristic of whooping cranes. In general, the unobstructed widths above and below the Diversion Weir were consistent with active channel widths (bank to bank), with the exception of one location above the Diversion Weir. This location had an elevated vegetated sandbar, decreasing the unobstructed width of this section of the channel.

All unobstructed widths, both above and below the Diversion Weir, generally fall below the noted range for this habitat parameter. On average, the channel is wider above the Diversion Weir than below the Diversion Weir; however, all channel widths fall within the generally accepted habitat preferences of whooping cranes, so little difference of potentially suitable channel widths and unobstructed widths exists when comparing above to below the Diversion Weir.

The percentage of channel width with water depths of 0.8 foot or less was evaluated using the 1-D HEC-RAS model. For current operations, the percentage of channel width with water depths of 0.8 foot or less is generally greater above the Diversion Weir than below. This percentage generally decreases with higher flow rates and from dry to wet years for both Site 1, upstream of the Diversion Weir, and under the no diversion condition for Site 2, downstream of the Diversion Weir.

The percentage of channel width with water depths of 0.8 foot or less increases as flow increases and as classification years proceed from dry to wet under current operations at Site 2, downstream of the Diversion Weir. In dry years, with low flow

conditions, there is a smaller percentage of channel width with water depths of 0.8 foot under current operations than under the no diversion condition (16 percent as opposed to 40 percent, respectively). Conversely, in a wet year, under high flow conditions, there is a higher percentage of channel width with water depths of 0.8 foot under current conditions than under the no diversion condition (36 percent as opposed to 8 percent, respectively). On average, above the Diversion Weir, percentages of the channel with water depths of 0.8 foot or less ranged from 39 percent of the channel width under low flows during a dry year to 25 percent under high flows during a wet year. Below the Diversion Weir under current operations, percentages of the channel with water depths of 0.8 foot or less ranged from 16 percent of the channel width during low flows in a dry year to 36 percent during high flows in a wet year. Below the Diversion Weir under the no diversion condition, percentages of the channel with water depths of 0.8 foot or less ranged from 40 percent of the channel width under low flows in a dry year to 8 percent under high flows in a wet year.

SECTION 6 STUDY 6.0, FISH SAMPLING

Consistent with the District's RSP (Loup Power District, July 27, 2009) and FERC's Study Plan Determination (FERC, August 26, 2009), Study 6.0, Fish Sampling, has been removed from the suite of studies that the District is performing in association with Project relicensing.

Study 6.0 Fish Sampling was originally proposed by NGPC during early Project scoping. In its infancy, the study was to consist of the District facilitation of NGPC-performed fish sampling along the Loup Power Canal.

Based on the widely accepted view that the Loup Power Canal is a healthy and important recreational fishery, and due to the lack of scoping-derived issues related to this fishery, the District announced its intention during the May 27-28, 2009, Study Plan Meeting to exclude this study from the RSP. All meeting participants, including NGPC, accepted this proposal without objection.

In August 2010, however, NGPC conducted sampling in the Loup Power Canal and Lake North independent of Project relicensing. As of March 2012, NGPC had not published its fish sampling report for this sampling event. Sampling results determined that both the Loup Power Canal and Lake North contain multi-species fishery assemblages as 18 fish species were collected. Of these, nine species are generally classified as sport fish: black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictus olivaris*), largemouth bass (*Micropterus salmoides*), white bass (*Morone chrysops*), sauger (*Sander canadense*), and walleye (*Sander vitreus*). Other species such as freshwater drum (*Aplodinotus grunniens*), common carp (*Cyprinus carpio*), and smallmouth buffalo (*Ictiobus bubalus*) are also sought by a small portion of the angling public. The sampling effort determined the most abundant sport fish species to be channel catfish, flathead catfish and white crappie; freshwater drum are also abundant and provide for angling opportunity. Other sport fish species were found in low numbers.

SECTION 7 STUDY 7.0, FISH PASSAGE

7.1 GOALS AND OBJECTIVES OF STUDY

The goal of the fish passage study is to determine if a useable pathway exists for fish movement upstream and downstream of the Diversion Weir.

The objectives of the fish passage study are as follows:

1. To evaluate the hydraulic flow, velocity, and stage parameters at the Diversion Weir and Sluice Gate Structure.
2. To determine whether fish pathways exist over the Diversion Weir, through the Sluice Gate Structure, or by other means.

7.2 STUDY AREA

The study area includes the Loup River reach directly upstream and downstream of the Headworks. The following two USGS gage stations were used to obtain data for the analysis:

- USGS Gage 06793000, Loup River near Genoa, NE – Available data for this station includes 15-minute interval discharge data from April 1, 1929, to current and 15-minute interval gage height data from June 12, 1997, to current.
- USGS Gage 06792500, Loup River Power Canal near Genoa, NE – Available data for this station includes 15-minute discharge data from January 1, 1937, to current and 15-minute interval gage height data from August 30, 2000, to current.

7.3 METHODOLOGY

Hydraulic data were analyzed via a hydraulic model to determine if, and how frequently, Loup River stage and resulting flow velocities result in usable fish pathways over or around the Diversion Weir or through the Sluice Gate Structure. This analysis focused on the spawning migration season of representative Loup River fish species (defined as April, May, and June) and compared resulting Loup River flow velocities to both the critical and burst swimming speeds of these fish species.

7.4 RESULTS AND DISCUSSION

The Diversion Weir is submerged and provides a potential pathway for upstream migrating fish during approximately 1 percent of the spawning season (defined as April through June for this analysis). During the 1 percent of the spawning season in which the Diversion Weir is submerged, the resulting flow velocities over the Diversion Weir are higher than the critical swimming speeds of all analyzed fish species. With the exception of the white sucker and walleye, the flow velocities that

result from Diversion Weir submergence are also too great to allow fish passage, even when burst swimming speeds are considered. Findings suggest that white sucker and walleye may be able to pass over the Diversion Weir during the 1 percent of the spawning season when the Diversion Weir is submerged, assuming that these species can maintain the top end of their documented burst swimming speed for 15 seconds.

The Sluice Gate Structure does not provide a fish pathway, due to the lack of time that the Gate Structures are open as well as the high flow velocities that are conveyed through the Gate Structures when they are open.

An alternative fish pathway around the Diversion Weir on the right bank of the Loup River (looking downstream) exists (on average) less than 1 day out of every spawning season. The findings summarized for the Diversion Weir above are also applicable to an alternative fish pathway around the Diversion Weir.

At the September 9, 2010, ISR meeting, questions were raised regarding whether or not the analysis would change if minimum velocities or a lower quartile velocity were used in the analysis, as fish would seek out the lowest velocities when trying to pass the diversion weir and sluice gate structure. On November 24, 2010, the District filed the following response:

> The District's analysis of fish passage at the Diversion Weir and Sluice Gates used a 1-Dimensional (1-D) hydraulic model that assumes a constant velocity across the channel cross section. A spatially varying velocity field is beyond the capability of a 1-D model. Although the model assumes a constant velocity, in reality there are boundary layers near solid surfaces and hydraulic shadows associated with hydraulic structures, particularly at the interface of corners of the wall and floor. The velocity in these areas is moving very slowly compared to the calculated average velocity through the gate. A fish could work up near the gate, hang out in a hydraulic shadow, and then burst through following the concrete along the gate housing. This type of behavior has been documented at hydraulic structures on the Mississippi River (Melvin Price Locks and Dam, Progress Report 1999 [USACE, May 2000]). Given these hydraulic conditions and the known species diversity upstream and downstream of the Diversion Weir, fish passage is likely occurring at the District's headworks, particularly by larger and stronger adult fish.
>
> Additionally, there are other possible fish passage situations for which a 1-D model does not account: 1) Debris could build up near the Sluice Gates and block flow, thereby reducing velocities enough to allow fish to pass through the Sluice Gates, 2) Ice could also build up near the Sluice Gates and block flow, thereby reducing velocities enough to allow fish to pass through the Sluice Gates.

After considering the provided response, and as documented in their December 20, 2010, Determination on Requests for Modifications to the Study Plan, FERC is not requiring that any additional analysis be performed.

SECTION 8 STUDY 8.0, RECREATION USE

8.1 GOALS AND OBJECTIVES OF STUDY

The goal of the recreation use study is to determine the public awareness, usage, perception, and demand of both the Project's existing recreation facilities (including fisheries) and the Loup River bypass reach (including the Loup Lands Wildlife Management Area [WMA]), to determine if potential improvements are needed, and to develop a Recreation Management Plan to address existing and future recreation needs.

The objectives of the recreation use study are as follows:

1. To measure recreation usage of Project recreation facilities (including fisheries) and the Loup River bypass reach (including the Loup Lands WMA).
2. To document the types of recreation use occurring at Project recreation facilities and along the Loup River bypass reach.
3. To determine whether Project recreation facilities meet current demand.
4. To determine the public's perception and awareness of Project recreation facilities, including fisheries, and to identify the impact of Project operations on recreation experiences.
5. To determine what species anglers are targeting and catching, including catch rates.
6. To collect data for use in the preparation of a Recreation Management Plan for the District's facilities.

8.2 STUDY AREA

Almost all of the 5,200 acres within the Project Boundary are open and accessible for public recreation. Although non-angling recreation use will be documented along the entire Loup Power Canal and Loup River bypass reach, special emphasis will be applied to the following recreation areas:

- Headworks Park – parking areas, camp sites, picnic areas, identified fishing sites, and Headworks OHV Park
- Lake Babcock Park (aka Loup Park) – parking areas, camp sites, picnic areas, shoreline, and in Lake Babcock
- Lake North Park – parking areas, camp sites, picnic shelters, shoreline, and in Lake North
- Columbus Powerhouse Park – parking area, picnic area, and identified fishing sites

- Tailrace Park – parking area, identified fishing sites, and playground
- Loup Lands WMA – all three tracts (Tracts G, H, and D) in accordance with FERC's Study Plan Determination (August 26, 2009)

The creel survey will span the length of the Loup Power Canal and will include Lake Babcock and Lake North. In addition, a recreation use/creel survey will be conducted on the Loup River bypass reach, which includes the Loup River from the Headworks to the confluence with the Platte River and the Platte River from the confluence to the Outlet Weir.

8.3 METHODOLOGY

Task 1 Pre-Survey Activities

In response to the Study Plan Determination requirement to survey the Loup River bypass reach for recreation use, the District initiated a separate study plan to detail this effort. Following NGPC and National Park Service (NPS) comments and the District's incorporation of provided comments, the plan was provided to FERC for review. Following incorporation of multiple FERC comments, the study plan was finalized.

District staff and District representatives attended a meeting on February 11, 2010, during which NGPC staff trained attendees as survey proctors. Established NGPC protocols and standard practices for surveying were explained and discussed regarding their incorporation into the recreation survey. Also during this meeting, final survey schedules were established in accordance with NGPC protocols for randomizing survey efforts. All active survey proctors not in attendance during the February 11, 2010 NGPC training were subsequently trained by District representatives present at the formal training.

To encourage participation in the survey, signs notifying users of the recreation survey were posted at multiple entry points to the District's recreation facilities.

Task 2 Data Collection

Data collection was performed via in-person and windshield mail-back surveys (recreation use and creel surveys) and field observations. Consistent with the NGPC-produced survey schedule, surveys began on May 4; included Memorial Day, Independence Day, and Labor Day; and concluded on October 30, 2010. The creel survey consisted of a progressive count bus route creel survey design in which pressure counts were conducted concurrently with interviews.

Three infrared trail counters were installed and began collecting user data, including data on both pedestrians and bicyclists, on April 30, 2010. One trail counter was installed at an approximate midpoint of each the District's three trails: 1) Two Lakes Trail, 2) Bob Lake Trail, and 3) Robert White Trail. Trail counts continued through October 2010.

A telephone survey of residents in Nance and Platte counties was conducted by a professional market research firm between May 26 and June 9, 2010. The survey sampled 400 randomly identified households with zip codes in Nance or Platte County in order to determine the general awareness and perception of the Project's recreational opportunities.

Task 3 Data Analysis

Survey responses were analyzed for trends and notable observations. Both count and percent values, along with verbatim responses, were analyzed. Narrative explanations of findings were developed to accompany collected count and percent survey data and to highlight the most applicable and relevant findings. For each recreation facility, usage estimates (including annual, average weekday, average weekend day, and holiday weekend day) were prepared and the ability of existing District recreation facilities to meet both current and future recreation demand was determined. Survey responses, anecdotal District observations, and camper counts were assessed to determine the capacity at which existing District facilities were operating.

Data collected from angler interviews and pressure counts were entered and analyzed using NGPC's Creel Survey Computer System. Estimates of fishing pressure/angler hours; mean party size; mean trip length; catch, harvest, and release by species; and catch, harvest, and release rates by species were computed.

Task 4 Recreation Management Plan

The District has prepared its Recreation Management Plan, which includes proposed improvements at the majority of the District's developed recreation areas. The Recreation Management Plan is included in the Final License Application, Volume 2, Exhibit E.

8.4 RESULTS AND DISCUSSION – GENERAL RECREATION USE

The following is a summary of notable observations and conclusions from the general Recreation Use study.

8.4.1 Facility Inventory

The facility inventory taken along the Loup Power Canal and the Loup River bypass reach determined that District-owned facilities include a variety of developed recreation amenities. Conversely, with the exception of the District's Weir Park (within Headworks Park) and the City of Columbus's Pawnee Park, locations providing public access to the Loup River bypass reach consist of undeveloped WMAs that include no recreational amenities beyond gravel parking areas.

8.4.2 Loup Power Canal Survey Responses

Based on collected survey responses, those recreating along the Loup Power Canal most commonly:

1. Live within 25 miles of District facilities.
2. Use District facilities because they are close to home.
3. Recreate either alone or with a single guest.
4. Do not stay overnight.
5. Visit District facilities on a weekly basis.
6. Visit during the summer months of May, June, July, and August.
7. Describe themselves as white (non-Hispanic, Latino, or Spanish).
8. Earn an annual household income between $26,000 and $50,000.

Notable exceptions to the above list include users of Headworks OHV Park. This group often travels well over 25 miles to access the unique recreation opportunity afforded by the park. As they reside in areas farther removed from District facilities, their frequency of visitation is two to three times per year and corresponds with the spring and fall Nebraska Off Highway Vehicle Association (NOHVA) jamborees.

Fishing from shore, "relaxing/hanging out," camping, and OHV riding were the most commonly cited activities in which respondents participate. Similarly, these activities, along with wildlife/scenic viewing and picnicking, were noted as the most important activities by respondents.

Respondents generally gave District recreation facilities high ratings. District trails and Headworks OHV Park received the highest ratings, whereas restrooms and parking received the lowest.

8.4.3 Trail Counts

Collected trail count data suggest the following:

1. The most trail use occurs in May; trail traffic is very consistent from June through September and decreases in October.
2. Two Lakes Trail receives 59.5 percent of the total trail traffic; Bob Lake Trail receives 25.7 percent; and Robert White Trail receives 14.8 percent.
3. Trail traffic is generally consistent throughout the work week and increases slightly on the weekend.
4. Two Lakes Trail receives a daily average of 71.9 trips/day; Bob Lake Trail receives 31.0 trips/day; and Robert White Trail receives 17.9 trips/day.

5. Essentially no trail users are present between 9:00 p.m. and 6:00 a.m. Trail use begins at approximately 6:00 a.m. and is moderate and consistent through the morning hours. Trail use increases following the lunch hour and remains consistent through approximately 8:00 p.m., when usage drops off sharply.

8.4.4 Use Estimates of District Recreation Sites

The estimated average weekend recreation use is roughly three times that of the estimated average weekday use. Overall, Headworks Park is the most frequently visited recreation site, followed by Lake North Park. Whereas visits to Lake North Park are highest on weekdays, visits to Headworks Park are highest during the weekend, including holiday weekends. Memorial Day weekend was the busiest time for District recreational facilities in 2010. Independence Day weekend visitation was down and likely affected by rain events recorded in the study area. In total, and based on 2010 survey and observation data, the District's entire recreation system is estimated to receive approximately 82,000 annual user visits.

8.4.5 Capacity of and Demand for District Recreation Sites

Overall, District facilities provide adequate recreation capacity for the population of Platte and Nance counties. Exceptions include camping capacity at Lake North and Headworks Park when holiday weekends coincide with desirable weather, and camping capacity at Headworks Park during the spring and fall NOHVA jamborees. Additional demand on District recreation facilities is not anticipated, as the population of Platte and Nance counties is essentially static and the findings of the NGPC 2009 statewide recreation survey indicate that outdoor recreation is generally decreasing in Nebraska.

8.4.6 Loup River Bypass Reach Survey Responses

Based on collected survey responses, those who recreate along the Loup River bypass reach most commonly:

1. Live within 25 miles of the Loup River bypass reach.
2. Recreate either alone or with a single guest.
3. Do not stay overnight.
4. Visit the Loup River bypass reach on a weekly basis.
5. Visit the Loup River bypass reach during the summer months of May, June, July, and August.
6. Access the Loup River bypass reach from either Headworks Park, Pawnee Park, or private property.
7. Have never visited Loup Lands WMA.

8. Describe themselves as white (non-Hispanic, Latino, or Spanish).
9. Earn an annual household income between $26,000 and $50,000.

A notable exception to the above list is the timing of visitation at the Loup Lands WMA. Respondents indicate that the greatest amount of WMA visitation occurs in the fall and spring, concurrent with Nebraska hunting seasons and prime morel mushroom season.

Fishing from shore, "relaxing/hanging out," swimming/wading, hiking, camping, mushroom hunting, walking/running, and OHV riding were the most commonly cited activities in which respondents participate.

8.4.7 Need for Additional Data Collection

Data collected during both the telephone survey and in-person recreation surveys performed along both the Loup Power Canal and Loup River bypass reach suggest that minimal recreation occurs outside of the May 1 to October 31 period encompassed in the District's data collection efforts to date. Therefore, the District proposes that no additional data collection is necessary in 2011.

8.5 RESULTS AND DISCUSSION – CREEL SURVEY

The following provides a brief summary of results derived from the 2010 creel survey, performed along the Loup Power Canal between May 1 and October 31, 2010.

8.5.1 Fishing Pressure/Angler Hours

Total fishing pressure along the Loup Power Canal during the open water fishing season of 2010 is estimated to be 32,766 angler hours, or 404 angler hours per hectare. Angler effort estimates are highest for the months of September (7,739 hours) and May (6,531 hours), and shore fishing is estimated to account for more than 94 percent of the angler hours expended (as opposed to fishing from a boat). The 2010 creel survey estimates that angler effort in 2010 was 265 percent and 118 percent of the estimated angler hours associated with the 1996 and 1997 NGPC surveys, respectively.

8.5.2 Catch, Release, and Harvest Estimates

Anglers fishing the Loup Power Canal between May 1 and October 31, 2010, harvested an estimated 8,973 fish (all species and fishing methods combined). This figure includes an estimated channel catfish harvest of 4,185, which is nearly 47 percent of the overall harvest. Overall and channel catfish-specific harvests were most abundant in October, despite estimated catch values peaking in May. Other species commonly harvested in 2010 included freshwater drum (22.2 percent), crappie species (12.4 percent), and white bass (9.1 percent).

The estimated number of fish caught and released on the Loup Power Canal from May 1 to October 31, 2010, is 11,843. Release estimates exceeded the number of fish harvested for every species except white bass, bluegill, and sauger.

8.5.3 Catch, Release, and Harvest Rates

The average harvest rate for all anglers fishing the Loup Power Canal from May 1 to October 31, 2010, was 0.30 fish/angler-hour. The highest estimated catch rates occurred in May (1.31 fish/angler-hour) and October (0.86 fish/angler-hour), respectively. The highest estimated harvest rate occurred in October (0.57 fish/angler-hour).

The average channel catfish harvest rate (for anglers targeting channel catfish) was 0.22 fish/angler-hour. The highest associated catch rates occurred in July (0.65 fish/angler-hour) and October (0.52 fish/angler-hour), whereas the highest estimated harvest rate occurred in May and October (0.35 fish/angler-hour).

8.5.4 Angler Demographics and Satisfaction

More than 99 percent of the anglers surveyed along the Loup Power Canal between May 1 and October 31, 2010, were Nebraska residents. More specifically, over 58 percent of surveyed anglers reside in Platte County, Nebraska (which includes the City of Columbus).

Angling parties averaged 1.75 members in size, indicated a mean completed trip length of 2.90 hours, and fished an estimated 766.10 angler days.

The majority of the surveyed anglers (64.5 percent) were targeting channel catfish, while 9.7 percent and 9.3 percent were targeting “anything” and walleye/sauger, respectively.

According to the collected data, the vast majority (over 87 percent) of anglers describe themselves as white (non-Hispanic, Latino, or Spanish). Additionally, more than 11 percent of anglers describe themselves as white (Hispanic, Latino, or Spanish). The most common annual household income range reported by anglers was $26, 000 to $50,000 (more than 42 percent). Respondent frequency generally decreased as income increased.

Fifty-seven percent of respondents rated shore fishing opportunities along the Loup Power Canal as “Excellent” or “Above Average.” An additional 35 percent of respondents rated shore fishing opportunities as “Average.”

SECTION 9 STUDY 9.0, CREEL SURVEY

Consistent with the District's RSP (Loup Power District, July 27, 2009) and FERC's Study Plan Determination (FERC, August 26, 2009), Study 9.0, Creel Survey, has been incorporated in Study 8.0, Recreation Use, and is no longer a stand-alone study.

The combination of the two studies was based on agency input provided during the May 11, 2009, Recreation, Land Use, and Aesthetics Study Plan Meeting. During this meeting, it was determined that Study 8.0, Recreation User Survey, and Study 9.0, Creel Survey (as defined in the District's PSP) could be combined into a single study that would allow increased survey efficiency.

SECTION 10 STUDY 10.0, LAND USE INVENTORY

10.1 GOALS AND OBJECTIVES OF STUDY

The goal of the land use inventory is to determine specific land uses of Project lands and adjacent properties to identify potential conflicts and/or opportunities relating to Project operations, public access, recreation, aesthetics, and environmental resource protection.

The objectives of the land use inventory are as follows:

1. To identify and record current and proposed future land uses of Project lands.
2. To identify and record current and authorized future land uses of adjacent properties.
3. To identify and map all existing public access points to the Loup Power Canal, regulating reservoirs, and defined recreation areas on Project lands.
4. To identify and map any areas on Project lands or adjacent properties having potentially incompatible or conflicting land uses.
5. To identify and map potential opportunities for improving public access to Project lands and recreation areas.
6. To identify potential opportunities to improve aesthetics on Project lands and recreation areas.
7. To identify potential opportunities to enhance public safety on Project lands.
8. To identify potential solutions for any land use conflicts that may be identified.
9. To provide information on land use, land use conflicts, and access to be used in conjunction with the results of Study 8.0, Recreation Use, to develop a recreation management plan.

10.2 STUDY AREA

The Project extends approximately 35 miles from the Headworks to the Outlet Weir, and the Project Boundary encompasses approximately 5,200 acres of land. Loup Power District owns all lands within the Project Boundary. A large portion of the Project consists of the Loup Power Canal, with a nominal width of 300 feet. The majority of adjacent land is agricultural and is considered compatible with the Project. Areas that may present conflicts or opportunities relating to Project operations, public access, recreation, aesthetics, and environmental resource protection include urban areas, public access points, the five developed recreation areas, and important

environmental features or habitat. Specific land uses of Project lands and adjacent properties at the following sites were carefully evaluated:

- Headworks Park, including Headworks OHV Park
- Lake Babcock Park (aka Loup Park)
- Lake North Park
- Columbus Powerhouse Park
- Tailrace Park
- Loup Lands WMA (leased to NGPC)
- Lake Babcock Waterfowl Refuge (regulated by NGPC)
- North Sand Management Area
- South Sand Management Area
- Siphons
- Areas with evidence of heavy informal usage
- Urban areas of Genoa and Columbus

10.3 METHODOLOGY

Land use classifications were assigned for Project lands and adjacent properties using District maps, applicable comprehensive plans (Nance County and City of Columbus), and available aerial photography. Field observations were also completed to gather detailed land use information for developed areas and for any other areas for which review of aerial photographs provided insufficient information. Land use maps were developed to display the determined land uses and other relevant information.

Based on determined land uses, areas of current land use conflicts and potential future land use conflicts were identified and possible mitigation measures were determined. Additionally, opportunities for improving Project operations, public access, recreation, aesthetics, and environmental resource protection were evaluated.

10.4 RESULTS AND DISCUSSION

The Project has operated for more than 70 years in rural Nance and Platte counties. The Project is a complementary land use to the surrounding area, providing irrigation and recreation opportunities. Despite its 35-mile footprint, the Project's impact on surrounding land is minimal. The Loup Power Canal is a passive presence, running adjacent to private agricultural land for the majority of its length. Public interaction with the Project is concentrated at improved recreation areas, siphons, and major roadway intersections.

The following conclusions have been reached regarding the land use inventory:

- In general, Project land use and operations were found to be compatible with adjacent properties.
- Future land use plans for Nance County and the City of Columbus do not indicate future land use conflicts.
- Restricted Operations Areas are safely separated from publicly accessible areas and do not conflict with recreation opportunities. Restricted Operations Areas total approximately 556 acres.
- Approximately 90 percent of the Project lands are accessible to the public from numerous locations—improved recreation areas, land classified as Wildlife Management Areas, the Loup Power Canal, and siphons.

SECTION 11 STUDY 11.0, SECTION 106 COMPLIANCE

11.1 GOALS AND OBJECTIVES OF STUDY

The goal of the Section 106 compliance study is to achieve National Historic Preservation Act (NHPA) Section 106 (16 USC 470f) compliance through a programmatic, ongoing consultation relationship between the District and Nebraska SHPO.

The objectives of the Section 106 compliance study are as follows:

1. To review existing information with FERC and the Interested Parties (Nebraska SHPO, the Pawnee Tribe, the Iowa Tribe of Kansas and Nebraska, the Omaha Tribe, the Santee Sioux Tribe, and the Ponca Tribe of Nebraska) to identify consultation needs and additional archival and field data collection requirements.
2. To gather sufficient information to identify any historic properties that may be affected by the Project.
3. To conduct field studies to identify and evaluate historic properties, including archaeological properties and elements of the standing structure/built environment as well as properties of traditional religious and cultural value important to Native American tribes.
4. To document the historic properties in the Area of Potential Effects (APE) and, as applicable, to present management recommendations in technical reports, an ethnographic memorandum, and a historic district documentation package.
5. To develop, in consultation with Nebraska SHPO, Native American tribes, and the Advisory Council on Historic Preservation (ACHP), a Historic Properties Management Plan (HPMP) in accordance with FERC guidelines (FERC, May 20, 2002).
6. To develop a Programmatic Agreement (PA) to complete the Section 106 compliance process and to incorporate in the Project license (this is a standard procedure carried out by FERC).

11.2 STUDY AREA

The study area is the APE, or Project Boundary, which encompasses the entirety of the District's holdings that are subject to the relicensing effort described in the PAD (Loup Power District, October 16, 2008). On January 23, 2009, Nebraska SHPO concurred that the Project Boundary, as defined in the PAD, is the APE.

11.3 METHODOLOGY

Task 1 Phase IA Archaeological Overview

Prior to the field studies, the District prepared an archaeological resources overview, also referred to as a Phase IA investigation, of the APE for the Project. The Phase IA investigation documented the known archaeological resources in the vicinity of the Project and identified areas where intact archaeological resources may exist.

Task 2 Phase I/II Archaeological Inventory and Evaluation

In the spring of 2010, the District conducted archaeological field studies of areas identified in the Phase IA investigation as having the potential for intact archaeological resources. The field studies identified and evaluated historic properties, including prehistoric and historic archaeological sites.

Task 3 Ethnographic Documentation

The District, in consultation with Native American tribes, documented any known places within the APE that are of traditional religious and cultural importance to the tribes. If locations of traditional religious and cultural importance are identified, the District will consult with FERC, Nebraska SHPO, and the tribes to ascertain the eligibility of these locations for listing on the National Register of Historic Places (NRHP) and the nature of any adverse effects. If necessary, the District will address these findings in its HPMP, discussed under Task 5.

Task 4 Historic Building Inventory and Evaluation

The District inventoried and evaluated the potential historic district identified during early coordination with Nebraska SHPO. The review included standing structures and other engineering features within the APE. This was done in accordance with Federal standards and state guidelines for documentation and provides a documentation package for the property.

Task 5 Historic Properties Management Plan

Based on the results of the studies and documentation efforts discussed in Tasks 1 through 4, the District prepared an HPMP to summarize the existing conditions of historic properties within the APE; assess reasonably foreseeable adverse effects of operations or maintenance on the historic properties; and establish notification, consultation, and reporting procedures that take into account these effects throughout the licensing period.

Task 6 Executed Programmatic Agreement

The executed PA will include signatures from FERC, Nebraska SHPO, Native American tribes, and possibly ACHP to complete Section 106 requirements. The PA is the legal mechanism that implements the HPMP and provides documentary evidence of compliance with Section 106.

11.4 RESULTS AND DISCUSSION

Task 1 Phase IA Archaeological Overview

The Phase IA Archaeological Overview determined that field studies were necessary for eight areas within the Project Boundary that appear to be undisturbed since the 1930s, or to be within or near documented archaeological sites. These areas retain the greatest potential to illustrate the nature and condition of any archaeological remains within the Project Boundary. Nebraska SHPO concurred with the recommendations in the Phase IA Archaeological Overview on November 11, 2009. The eight sites recommended for field work are documented in the Phase I/II Archaeological Inventory and Evaluation.

The Phase IA Archaeological Overview contains privileged information and has been filed with FERC as privileged information. As such, detailed results of the study are not included here.

Task 2 Phase I/II Archaeological Inventory and Evaluation

The study area included eight study sites, as identified and described in detail in the Phase 1A Archaeological Overview. In addition, the perimeter of the entire Loup Power Canal corridor was examined for potential archaeological resources that had not been previously identified. Pedestrian surveys performed in these areas verified surface evidence for six previously recorded sites and one new site.

Eighty-three shovel tests were completed at the study sites and along the canal corridor to examine subsurface soil deposits and to determine if subsurface archaeological materials were present. Archaeological material was recovered from dry-screened fill removed from seven (8.43 percent) of these shovel tests. Prehistoric archaeological material was found in three of these shovel tests, and historic artifacts were recovered from the remaining four shovel tests.

Based on this evaluation, it is recommended that one of the tested sites is eligible for listing on the NRHP; however, further investigation of this site would likely be required. Other, sensitive areas of the canal corridor were identified and should be managed through consultation with Nebraska SHPO and possibly monitored by a professional archaeologist during ground-disturbing activities.

Nebraska SHPO concurred with the findings of the Phase I/II Archaeological Inventory and Evaluation on September 15, 2010. The document was also submitted to applicable Native American tribes for review and comment and was subsequently filed with FERC in February 2011. Because the Phase I/II Archaeological Inventory and Evaluation contains privileged information, it has been filed with FERC as privileged information and detailed results of the study are not included here.

Task 3 Ethnographic Documentation

The following tribes were contacted regarding potential input to the ethnographic investigation:

- Omaha Tribe of Nebraska
- Pawnee Nation of Oklahoma
- Ponca Tribe of Nebraska
- Ponca Tribe of Oklahoma
- Santee Sioux Tribe of Nebraska
- Winnebago Tribe of Nebraska

None of the contacted tribes responded with information related to places that are of traditional religious and cultural importance. The apparent lack of interest by the tribes regarding the Project may represent reluctance, by some, to divulge sensitive information. The District coordinated with applicable tribes to provide notice of availability of the Phase IA Archeological Overview. The Phase I/II Archaeological Inventory and Evaluation was also provided to tribes and concurrently to Nebraska SHPO.

Task 4 Historic Building Inventory and Evaluation

The Historic Building Inventory and Evaluation determined that the Project is a historic district consisting of property eligible for listing on the NRHP. The Project consists of 16 properties that exhibit individual eligibility and 20 properties that lack individual eligibility but contribute to the historic district. The historic district also includes non-contributing properties that are not eligible for listing on the NRHP. The LPD historic district's eligibility is based on Criteria A, B, and C, as set forth in 36 CFR 60.4 and reprinted in National Park Service Bulletin 15, "How to Apply the National Register Criteria for Evaluation" (2002). The Project does not appear to meet the requirements for eligibility under Criterion D. The LPD historic district is significant because it is a potential example with extraordinary historic integrity of a vital national program of rural electrification from the 1930s. Nebraska SHPO concurred with these findings on September 15, 2010. The Historic Building Inventory and Evaluation was subsequently filed with FERC in September 2010.

Task 5 Historic Properties Management Plan

The District has prepared its HPMP and provided it to Nebraska SHPO and Native American Tribes for review. Nebraska SHPO concurred with the HPMP on March 12, 2012. To date, no comments have been received from Native American tribes. The District's HPMP is included in the Final License Application, Volume 4, Privileged. Following FERC approval of the HPMP, a Programmatic Agreement will be developed in consultation with FERC and Nebraska SHPO.

Task 6 Executed Programmatic Agreement

Following HPMP approval, the PA will be developed in consultation with FERC and Nebraska SHPO.

SECTION 12 STUDY 12.0, ICE JAM FLOODING ON THE LOUP RIVER

12.1 GOALS AND OBJECTIVES OF STUDY

The goal of the study of ice jam flooding on the Loup River is to evaluate the impact of Project operations on ice jam flooding on the Loup and Platte rivers between Fullerton, Nebraska, and North Bend, Nebraska. The study will also develop an ice jam and/or breakup predictive model (limited to examination of Project effects), as well as identify operational or structural measures to mitigate or minimize Project effects on ice jam formation and subsequent flooding, if it is demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte rivers.

The objectives of the study of ice jam flooding on the Loup River are as follows:

1. To evaluate the effect of Project operations on hydrology, sediment transport, and channel hydraulics on ice processes in the Loup and lower Platte rivers.
2. To develop an ice jam and/or breakup predictive model to evaluate Project effects.
3. To identify structural and nonstructural methods for the prevention and mitigation of ice jams, should it be demonstrated that operation of the Project materially impacts ice jam formation on the Loup and Platte Rivers.

12.2 STUDY AREA

The study area includes the Loup River from Fullerton (approximately 7 miles upstream of the Loup Power Canal Headworks) to the confluence with the Platte River (the Loup River bypass reach), the Platte River from just upstream of the confluence of the Loup and Platte rivers to North Bend, and the Loup Power Canal from the Headworks to the Tailrace Canal confluence with the Platte River below the Loup-Platte confluence.

12.3 METHODOLOGY

The District has contracted with USACE to perform the ice jam study as outlined in FERC's Study Plan Determination. The study includes the following tasks.

Task 1 History of Ice Jams

Available records of ice jam flood events, from before and after Project construction, were analyzed and compared to determine if any statistical basis exists to indicate that Project operations may have a significant incremental effect on the occurrence or severity of these events.

Task 2 Hydrology and Sedimentation

Relevant components of hydrology and sedimentation information developed for the Sedimentation, Hydrocycling, and Flow Depletion and Flow Diversion studies were used by USACE in the ice formation, ice transport, and ice-affected hydraulics analyses being performed for this study.

Task 3 Ice Formation

Hydrometeorologic and discharge data have been collected and synthesized from various stations within and near the study area. The correlation between formation of frazil ice and hydrometeorologic conditions and discharge was determined using statistical methods. This analysis was correlated with actual field observations and power canal shutdowns during periods of frazil ice production. The total volume of frazil ice produced and the growth in ice cover thickness was estimated. The values for ice production and thickness will be used in Task 5, Ice-Affected Hydraulics.

Task 4 Ice Transport

If determined necessary, a DynaRICE hydraulic model would be developed for key locations to estimate differences in ice cover formation and/or jam formation that would be utilized in the ice-affected hydraulics analysis as appropriate.

Task 5 Ice-Affected Hydraulics

River cross section surveys have been completed although they had been delayed by heavy rains and high water. A HEC-RAS model was developed to compute the ice-affected hydraulics of the study area and to determine whether Loup Power Canal operations increase or decrease flood risk to overbank infrastructure.

Task 6 Identification of Methods for Prevention and Mitigation of Ice Jams

If it is demonstrated that Project operations increase flood risk to overbank infrastructure, structural and nonstructural means would be investigated that may prevent and/or mitigate impacts.

12.4 RESULTS AND DISCUSSION

A review of flood history shows that the occurrence of significant ice jam flooding has not increased since the Loup Power Canal commenced operations. A lack of historical data precludes a similar comparison of minor ice-affected flooding; however, a thorough review of climatological data and use of hydraulic models does not show a difference in the occurrence of minor ice-affected flooding due to operation of the Power Canal. Other factors, such as climatic variability and floodplain developments may lead to an increased flood risk during an ice jam; however, as these factors are often subtle over time, they may be overlooked as a cause of increased flood risk. It is the opinion of the authors (USACE) that the Loup

Power Canal has not significantly changed the ice regime of the Loup River between the Headworks and its confluence with the Platte, nor has it increased the risk of significant ice jam flooding.

SECTION 13 PCB FISH TISSUE SAMPLING

13.1 BACKGROUND

In response to the District's PAD (Loup Power District, October 16, 2008) and FERC's Scoping Document 1 (FERC, December 12, 2008), USFWS requested that the District perform studies to evaluate total PCBs within the Project area and immediately downstream (USFWS, February 9, 2009).

As a result of USFWS comments related to PCBs, FERC identified the following issue related to Project operations that could potentially mobilize PCBs (if they are present within the Project Boundary) (FERC, March 27, 2009):

> The potential exists for dredging operations to mobilize PCB-laden sediments if present in the settling basin. In addition, small fish discharged onto the North Sand Management Area with sediments during dredging activities could potentially contain PCBs. Such fish could be ingested by federally listed least terns nesting and feeding in the North Sand Management Area. Therefore, we have modified [Scoping Document 2] SD2 to show that we will assess the effects of project operations on PCB transport within the project area.

13.1.1 Revised Study Plan

The District's RSP (Loup Power District, July 27, 2009) included Response 3.0, in which, the District proposed to cooperate with NDEQ to conduct additional fish tissue sampling using existing PCB sampling protocols developed by NDEQ under the U.S. Environmental Protection Agency (EPA) Region VII Ambient Fish Tissue Monitoring Program (RAFTMP). More specifically, Response 3.0 states that NDEQ will perform additional fish tissue sampling in Lake Babcock in association with its regularly scheduled 2009 fish tissue sampling in the Tailrace Canal at the U.S. Highway 30 Bridge. Consistent with current procedures, the additional samples will be provided to the EPA Region VII laboratory in Kansas City, Kansas, for PCB analysis.

13.1.2 Study Plan Determination

In its Study Plan Determination issued on August 26, 2009, FERC determined that the District's sampling protocol specified in the RSP and in combination with the fish tissue sampling results presented in the PAD for the Project would be sufficient for the necessary analysis. In addition, FERC stated the following:

> The relevant issue for any licensing decision is whether any PCB mobilization caused by project operations affects fishery resources. To answer that question, it is most appropriate to first sample fish tissue for PCB's in the potentially affected reach (i.e., Lake Babcock) to

> determine if PCB's are presently affecting fish, regardless of the source…. Should elevated PCB levels be found in the fish tissues, we [FERC] may consider additional PCB monitoring in year 2.

13.2 GOALS AND OBJECTIVES OF STUDY

The goal of this study is to determine if Project operations affect PCB transport, and subsequently fishery resources, in the vicinity of the Project.

The objective of this study is to determine if the tissue of bottom-feeding fish collected from two locations in the vicinity of the Project contain PCBs.

13.3 STUDY AREA

The study area includes the entire Loup Power Canal. Specifically, fish tissue samples were collected at the following two locations:

- Lake Babcock
- Tailrace Canal at the U.S. Highway 30 Bridge

13.4 METHODOLOGY

The District facilitated NDEQ PCB fish tissue sampling in Lake Babcock on August 11, 2009, in association with NDEQ's regularly scheduled 2009 PCB fish tissue sampling in the Tailrace Canal at the U.S. Highway 30 bridge, which occurred on August 12, 2009. Five common carp were collected at each location, in accordance with existing PCB sampling protocols developed by NDEQ under the EPA RAFTMP. The fillets from each collected sample were composited into a single sample and were provided to the EPA Region VII laboratory in Kansas City, Kansas, for PCB analysis.

13.5 RESULTS AND DISCUSSION

Analytical results for PCB (Aroclor 1248, 1254, and 1260) concentrations at each sample/site were below the reporting limit for each contaminant[1] (coded "U" in the attached data, see Attachment 13A). For parameters where analytical results were above the reporting limit, NDEQ ran the data through its risk assessment[2] calculation

[1] Reporting limits are as follows: Aroclor 1248 = 0.04 mg/kg; Aroclor 1254 = 0.03 mg/kg; and Aroclor 1260 = 0.02 mg/kg.

[2] NDEQ's risk assessment methods are used to calculate cancer risks and hazard indices (non-carcinogenic risks) and ultimately assess human health risks associated with consuming fish.

tables. Neither sample/site exceeded current state risk criteria.[3] The summarized results, and those provided in Attachment 13A, have not been officially reported by NDEQ; however, it is anticipated that the data, as provided, will be included in NDEQ's 2009 Fish Tissue Report once all of the statewide data have been received and assessed. Considering the 2009 sample results, NDEQ has indicated that the current fish consumption advisory for the Loup Power Canal will likely be removed following completion of the 2009 Fish Tissue Report in late 2010 or early 2011.[4]

Based on the analytical study results, it is inferred that Project operations are not mobilizing PCBs that could affect fishery resources. Considering these results, it is the District's understanding that no further study is warranted concerning PCBs.

[3] The risk criteria established by the Nebraska Fish Tissue Advisory Committee include fish tissue that 1) are found to have mercury concentrations equal to or greater than 0.215 mg/kg, 2) have contaminant concentrations that may be associated with adverse health effects (Hazard Quotient greater than 1.0), or 3) may be associated with an excess cancer risk greater than or equal to 1 in 10,000 when ingested.

[4] NDEQ notes that even after the 2009 Fish Tissue Repot is finalized, the Loup Power Canal would not be removed from the Clean Water Act Section 303(d) list of impaired water bodies until NDEQ's 2012 Integrated Report (the final product resulting from the October 12, 2006, EPA-issued guidance for 2008 water body assessments and reporting requirements for Sections 303(d), 305(b), and 314 of the Clean Water Act) is finalized.

ATTACHMENT 13A

NDEQ FISH TISSUE SAMPLING DATA

ASR_Number	Sample_Number	Analysis_Name	Analyte_Name	Units	Final_Result	Detection_ID	Start_Date	End_Date	Location_Desc	Latitude	Longitude
Loup Power Canal											
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1248	mg/kg	0.04	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1254	mg/kg	0.03	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1260	mg/kg	0.02	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	G-BHC	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	cis-Chlordane	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Chlordane, technical	mg/kg	0.03	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	trans-Chlordane	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDD	mg/kg	0.004	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDE	mg/kg	0.005	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDT	mg/kg	0.005	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Dieldrin	mg/kg	0.003	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Heptachlor	mg/kg	0.003	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Heptachlor Epoxide	mg/kg	0.003	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Hexachlorobenzene	mg/kg	0.001	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	cis-Nonachlor	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	trans-Nonachlor	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Oxychlordane	mg/kg	0.002	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Pentachloroanisole	mg/kg	0.001	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Followup Fish Pesticides, Fillet, by GC/EC	Trifluralin	mg/kg	0.003	U	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Mercury in Tissue	Mercury	mg/kg	0.0755		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Metals in Fish by ICP-AES	Cadmium	mg/kg	0.02	UJ	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Metals in Fish by ICP-AES	Lead	mg/kg	0.14	UJ	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Metals in Fish by ICP-AES	Selenium	mg/kg	0.45	UJ	08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	Percent Lipid in Tissue	Lipid	%	2.1		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Average Length	mm	429.80		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Average Weight	Grams	1158.2		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	County	N/A	Platte		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Fish Species	I.D.	12		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Fish Species Name	N/A	CmmnCarp		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Fish Type	N/A	BtmFeedr		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Latitude	Dec. Deg.	41.43848		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Longitude	Dec. Deg.	97.28248		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Number of Specimens	#	5		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Sample Type	N/A	Followup		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	State	N/A	NE		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Targeting Rationale	N/A	Targeted		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Tissue Analyzed	N/A	Fillet		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Waterbody Name	N/A	LoupRvrCnl		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Waterbody Type	N/A	NonWade		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248
4647	105	RAFT Fish Field Parameters	Year	N/A	2009		08/12/2009	08/12/2009	Loup Power Canal, Columbus	41.43848	97.28248

ASR_Number	Sample_Number	Analysis_Name	Analyte_Name	Units	Final_Result	Detection_ID	Start_Date	End_Date	Location_Desc	Latitude	Longitude
Lake Babcock											
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1248	mg/kg	0.04	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1254	mg/kg	0.03	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Aroclor 1260	mg/kg	0.02	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	G-BHC	mg/kg	0.002	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	cis-Chlordane	mg/kg	0.002	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Chlordane, technical	mg/kg	0.03	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	trans-Chlordane	mg/kg	0.002	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDD	mg/kg	0.004	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDE	mg/kg	0.0078		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	p,p'-DDT	mg/kg	0.005	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Dieldrin	mg/kg	0.003	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Heptachlor	mg/kg	0.003	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Heptachlor Epoxide	mg/kg	0.003	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Hexachlorobenzene	mg/kg	0.001	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	cis-Nonachlor	mg/kg	0.002	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	trans-Nonachlor	mg/kg	0.0020		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Oxychlordane	mg/kg	0.002	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Pentachloroanisole	mg/kg	0.001	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Followup Fish Pesticides, Fillet, by GC/EC	Trifluralin	mg/kg	0.003	U	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Mercury in Tissue	Mercury	mg/kg	0.143		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Metals in Fish by ICP-AES	Cadmium	mg/kg	0.02	UJ	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Metals in Fish by ICP-AES	Lead	mg/kg	0.19	J	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Metals in Fish by ICP-AES	Selenium	mg/kg	0.45	UJ	08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	Percent Lipid in Tissue	Lipid	%	3.1		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Average Length	mm	499.40		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Average Weight	Grams	1881.2		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	County	N/A	Platte		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Fish Species	I.D.	12		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Fish Species Name	N/A	CmmnCarp		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Fish Type	N/A	BtmFeedr		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Latitude	Dec. Deg.	41.48772		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Longitude	Dec. Deg.	97.36406		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Number of Specimens	#	5		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Sample Type	N/A	Status		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	State	N/A	NE		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Targeting Rationale	N/A	Targeted		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Tissue Analyzed	N/A	Fillet		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Waterbody Name	N/A	LkBabcock		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Waterbody Type	N/A	Lake B		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406
4648	114	RAFT Fish Field Parameters	Year	N/A	2009		08/11/2009	08/11/2009	Lake Babcock, Columbus	41.48772	97.36406

SECTION 14 STUDY 14.0, ALTERNATIVE PROJECT OPERATIONS AND SEDIMENT MANAGEMENT

14.1 INTRODUCTION

Several studies were performed to examine potential Project effects related to sediment and flow in the Loup and lower Platte rivers, including Study 1.0, Sedimentation; Study 2.0, Hydrocycling; and Study 5.0, Flow Depletion and Flow Diversion. Following publication of the District's Updated Study Report (Loup Power District, August 26, 2011 and September 6, 2011), FERC requested a new study titled Alternative Project Operations and Sediment Management (FERC, December 21, 2011). Study methodology and results are summarized herein.

14.2 ALTERNATIVE PROJECT OPERATIONS ANALYZED

In the Study Determination on Requests for Modifications to the Loup River Hydroelectric Project Study Plan (FERC, December 21, 2011), FERC requested that the District analyze potential changes in sediment transport in the lower Platte River based on four alternative Project operations. The four alternatives that FERC requested to be studied are as follows:

- Alternative 1 – Release all material dredged from the Settling Basin to the Platte River at its confluence with the Loup Power Canal. This alternative would include construction and operation of a conveyance to transport dredged material from the Settling Basin (located at the head of the Loup Power Canal) to the confluence of the Loup Power Canal with the Platte River. Neither the existing North nor South Sand Management Area (SMA) would continue to be used for sediment disposal under this alternative.
- Alternative 2 – Release all material dredged from the Settling Basin to the South SMA. Under this alternative, all dredged material from the Settling Basin would be directed to the South SMA. Flow diversion into the Loup Power Canal would not change from existing Project operations. The North SMA would no longer be used for sediment disposal under this alternative.
- Alternative 3 – Release all material dredged from the Settling Basin to the South SMA and modify Project operations to allow sufficient flow to pass downstream into the Loup River bypass reach during high flow events to enhance sediment transport. The North SMA would no longer be used for sediment disposal under this alternative.
- Alternative 4 – Release all material dredged from the Settling Basin to the South SMA, modify Project operations to allow sufficient flows to pass into the Loup River bypass reach during high flow events to enhance sediment

transport, and modify Project operations to maintain a minimum flow in the Loup River bypass reach during the interior least tern (*Sternula antillarum athalassos*) and piping plover (*Charadrius melodus*) nesting season. This alternative would be identical to Alternative 3, except that Project operations would be modified during the interior least tern and piping plover nesting season to provide a minimum flow in the Loup River bypass reach to provide for the development and maintenance of interior least tern and piping plover nesting habitat.

Based on telephone consultation with FERC staff, it is the District's understanding that the intent of the analysis of these alternatives is not necessarily to identify an alternative operating condition but rather to evaluate how a change in operation could affect sediment transport and subsequently interior least tern, piping plover, whooping crane, and pallid sturgeon habitat. Gaining an understanding of how the Loup and Platte river systems would respond under different circumstances may help FERC identify Project effects and potential Project modifications and enhancements. Based on this understanding, an in-depth feasibility assessment of these alternatives as potential operational changes was not conducted.

14.3 STUDY AREA

Two study areas were identified for this study: a Loup River study area and a lower Platte River study area. The Loup River study area includes the reach approximately 5 miles upstream of the Diversion Weir and extends through the Loup River bypass reach to approximately 6 miles downstream of the Diversion Weir. The lower Platte River study area extends from the Loup River confluence to a point approximately 6 miles downstream of the confluence. The following gaged and "ungaged" sites, detailed in the District's Final License Application, Volume 3, Study 1.0, Sedimentation, are located within the two study areas:

- Loup River upstream of the Diversion Weir (Site 1)
- Loup River immediately downstream of the Diversion Weir (Site 2)
- USGS Gage 06792500, Loup River Power Canal near Genoa, NE
- USGS Gage 06793000, Loup River near Genoa, NE
- Lower Platte River downstream of the Loup River confluence and upstream of the Tailrace Return confluence (Site 3)
- Lower Platte River within 5 miles downstream of the Tailrace Return confluence (Site 4)

14.4 METHODOLOGY

Alternative 1 focused on the impact of an alternative sediment management scenario on sediment transport and channel geometry in the lower Platte River, while Alternatives 2, 3, and 4 focused on the impacts of alternative sediment management scenarios on sediment transport and channel geometry in the Loup River bypass reach.

The method selected for analysis of the lower Platte River as directed by FERC (Alternative 1) was the sediment transport module in HEC-RAS, as used for Study 2.0, Hydrocycling (see the Final License Application, Volume 3). The sediment transport analysis was supplemented by analysis of changes in associated sediment transport indicators and channel geometry.

The model reach for Alternative 1 includes the ungaged Sites 3 and 4. In Study 2.0, Hydrocycling, the modeled trend at Site 4 for current operations suggests that the Tailrace Return does not have a negative effect on sediment transport or dynamic equilibrium. The results indicated periods of both aggradation and degradation at Site 4, but overall showed a dynamic equilibrium condition. This means that the channel geometry downstream of the Tailrace Return has adjusted over time to pass the incoming sediment with the flow from the Tailrace Return.

The Loup River bypass reach (Alternatives 2, 3, and 4) as directed by FERC was analyzed through spreadsheet methods as performed for Study 1.0, Sedimentation (see the Final License Application, Volume 3) by simulating the FERC-prescribed changes in flows and sediment management. The impacts on sediment transport indicators and channel geometry were then determined using Yang's Unit Stream Power (USP) equation and historical relationships between channel-forming flow rates and associated geometric parameters for the Loup River near Genoa.

4.1 Methodology for Alternative 1 – Sediment Transport Analysis Using HEC-RAS

The original sediment transport model developed for Study 2.0, Hydrocycling (see the Final License Application, Volume 3), was used to evaluate Alternative 1. Consistent with modeling conducted for current operations, the simulation included a 3-year warm-up period from 1987 through 1990, with each daily flow set at the respective dominant discharge then daily flows based on the synthetic hydrographs for years 1990 through 2005. The period between 1990 and 2005 included equally proportional numbers of wet, dry, and normal hydrologic classifications, which provided a good representation of the hydrologic conditions over the simulation.

In order to improve stability, the downstream cross section in the Platte River was set as a pass-through node. This is standard modeling practice in HEC-RAS with conjoined, actively transporting stream segments, and is typically done at the downstream boundary condition, in conjunction with a normal depth downstream boundary. In addition, the original sediment transport model only required a flow change at the Tailrace Return since it was modeled with no sediment load to evaluate

the worst-case degradation condition. However, the model required a tributary channel to augment sediment into the river for this study. The tributary channel is referred to as the Tailrace Branch.

In summary, the original sediment transport model was modified to include a downstream pass-through boundary and the Tailrace Branch. This model will herein be referred to as the Alternative 1 Model. As noted in Study 2.0, Hydrocycling (see the Final License Application, Volume 3), the HEC-RAS literature states that sediment transport models should be used only to evaluate trends and not absolute rates of response either locally or longitudinally.

The results of the sediment transport modeling will be used in conjunction with regime graphics developed by Chang (March 1985) and Lane (1957) to assess the effects of Alternative 1.

4.2 Methodology for Alternatives 2, 3, and 4 – Sediment Transport Using Yang's USP Equation and Historical Channel Geometry Measurements

After receipt of FERC's Study Determination on Requests for Modifications to the Loup River Hydroelectric Project Study Plan, the District requested clarification from FERC staff on the specifics of evaluating Alternative 2 as described in Section 2. Specifically, the District noted that since Alternative 2 did not include a change in flow, there would be no change in the sediment transport calculations because the hydrograph would be unchanged. FERC staff indicated that the intent of Alternative 2 was an evaluation of the base case for comparison to Alternatives 3 and 4. Further, staff indicated that the sediment transport calculations performed for current operations in Study 5.0, Flow Depletion and Flow Diversion (see the Final License Application, Volume 3), would satisfy the analysis of Alternative 2 for this study.

Since both Alternatives 3 and 4 involve changes in hydrology, a sediment transport analysis was conducted to determine how sediment transport indicators and channel geometry would change from current operations for the following conditions:

- Alternative 3 – Project operations would be modified to allow sufficient flow to pass downstream into the Loup River bypass reach during high flow events.
- Alternative 4 – Project operations would be modified to allow sufficient flow to pass into the Loup River bypass reach during high flow events, supplemented by releases of a minimum maintenance flow in the Loup River bypass reach during the interior least tern and piping plover nesting season.

The analysis was performed at the Loup River near Genoa gage to determine whether the average channel characteristics (width, area, velocity, and depth) would differ from current operations based on the change in hydrology and subsequent sediment transport and associated sediment transport indicators. The Alternatives 3 and 4

analyses were performed for a typical wet, dry, and normal hydrologic classification on the Loup River bypass reach.

Synthetic hydrographs were developed for each studied operational modification. This was done based on visual inspection of the daily hydrographs corresponding to the wet, dry, and normal hydrologic classifications at the Loup River near Genoa gage and the Loup River Power Canal near Genoa gage. For Alternative 3, diverted flows were curtailed during the high flow events, bypassing more flow in the Loup River bypass reach. The same curtailments were applied for Alternative 4. In addition, Alternative 4 included minimum bypassed flows during the specified habitat-use seasons, which were assumed to be the 1-year dominant discharges for a wet, dry, and normal hydrologic conditions under current operations. These values are 1,730 cfs, 790 cfs, and 1,080 cfs, respectively, at the Loup River near Genoa gage.

The sediment transport calculations were performed using the flow-modified synthetic hydrographs and the long-term sediment discharge curve and equilibrium channel geometry relationships for the Loup River at Genoa.

The sediment transport indicators, total sediment transport amounts, and new dominant discharge rates were then calculated. Finally, the eventual equilibrium width, flow area, velocity, and depth that would be associated with the new dominant discharge for each flow modification were determined. The results were then compared to equilibrium channel geometries for current operating conditions, as well as the no diversion condition (developed in Study 5.0, Flow Depletion and Flow Diversion), for a wet, dry, and normal year.

14.5 RESULTS AND DISCUSSION

The results of the Alternative Project Operations and Sediment Management Study, along with a qualitative discussion of how alternative operations might affect interior least tern, piping plover, and pallid sturgeon habitat, are presented below.

5.1.1 Summary of Findings for Alternative 1

Both the sediment transport modeling and regime method analyses of Alternative 1 reveal that no particular enhancements in sediment transport or habitat would occur under any of the augmentation loads studied. Small, local increases in mean effective channel invert elevations would occur in response to the river's need for a steepened slope to create higher energy to carry the added sediment load. This would result with the low channel filling in, reducing the height of bars above the mean effective channel invert elevation. Because the dominant discharges for all of the augmentation scenarios at Site 4 are essentially the same as the current-operations values, no adverse or beneficial changes in channel geometry would likely occur.

The slope changes required for transporting the added sediment would be limited to relatively short distances around Sites 3 and 4. Because slopes steepen in and around the Tailrace Return, slopes farther downstream would theoretically also need to increase, or degradation at the downstream end of the steepened segment might be a concern. Because natural sediment supplies to the river currently increase in the downstream direction, the channel geometry at more distant downstream locations from the Tailrace Return have adjusted to successively higher sediment loads and are able to transport the sediment with successively smaller or zero increases in slope.

Interior least terns and piping plovers generally select nest locations with sparsely vegetated sand and gravel bars that remain above water for at least 100 days for interior least terns and 60 days for piping plovers. Nest sites in river channels are often in wide channels on un-vegetated sandbars. During the short period of aggradation, there would be a slightly higher risk of interior least tern and piping plover nest inundation. The long-term trend does not indicate any substantial difference in sandbar formation or channel geometry that would affect interior least terns or piping plovers.

Relative to the pallid sturgeon, the short-term effects of a slightly narrower channel at Site 3 and a slightly shallower channel at Site 4, may affect pallid sturgeon movement. However, it is not anticipated that these changes would be beyond the velocity ranges that would prohibit pallid sturgeon from entering Study Site 3 or 4.

5.1.2 Summary of Findings for Alternatives 3 and 4

The spreadsheet sediment transport calculations for Alternatives 3 and 4 show that there would likely be an increase in sediment transport if more flow is bypassed to the Loup River bypass reach. This would occur for both Alternatives 3 and 4. The changes in sediment transport indicators and associated changes in channel characteristics of width, area, and depth would be negligible.

The analyzed alternatives include supplementing flows in the bypass reach in order to transport a portion of the sand deposited on the South SMA. However, the bypassed flows associated with Alternatives 3 and 4 would already be transporting sediment at capacity. Therefore, the additional sand deposited on the South SMA for these alternatives would likely just accumulate on the South SMA, as happened prior to 1960.

With regard to sediment augmentation benefits, a 1 to 6 percent increase in a 320-foot-wide existing channel predicted for the two alternatives, or a 0.03 to 0.15 foot increase in depth, would not produce any measurable habitat improvements.

SECTION 15 REFERENCES

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